ENGINEERING NEWS

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The bill authorizing the construction of a bridge over the Mississippi River at New Orleans, La., has passed Congress, and preparations are being made to begin the necessary surveys. The bridge will be of the cantilever type with a center span of 1,095 ft., and two shore spans of 757 ft. each, at least 85 ft. above high water, and with two piers in the river. Its exact location will be determined by the surveys and borings soon to be made. The charter granted by Congress provides that one approach, if practicable, shall be within the city limits of New Orleans. In case it is found that the substratum near the city is not sufficiently firm to support the piers, it may be located not more than five miles above the city, but under no consideration may it be built below, since then it would possibly interfere with the ocean vessels. The place now practically selected for it is at Nine Mile Point, not far from Carrollton. The contract to build the bridge has been given to Corthell & Karner, Civil Engineers, of Chicago, Ill.

The value of the property of the Long Island Water Supply Co., which supplies the 26th Ward of Brooklyn, has been fixed at $570,000 by the commissioners appointed for that purpose. Of this sum $77,500 is awarded for the company's real estate; $292,500 for the works proper, including the pumping machinery, reservoirs and about 50 miles of mains; and $200,000 for the franchise and rights of the company. The valuation of the franchise was based upon the "assumptions (1) that at present the water company alone has the right publicly to purvey water in the 26th Ward; (2) that the exclusiveness now incident to its right may at any time be taken from it by the legislature or local authorities, acting under legislation; but (3) that neither the legislature nor local authorities would, in determining whether to take from the company the exclusiveness of its right, fail to have such due regard as is demanded by ample and fair public policy, to the past investments, risks and services of the company, and to the just expectations which those who invested money in its work had in mind when so investing."

The commission consisted of five members, residents and freeholders of Kings County, N. Y., appointed by the Supreme Court of the county. Three of the commissioners signed the report, and two presented a minority report, in which they agreed as to the valuation of all but the franchise, but this the minority did not set a valuation upon. The water company employed as expert engineers before the commission, Messrs. John Bogart, Alphonse Fteley and Wm. Barclay Parsons. On the city's side there were employed Messrs. Samuel McElroy, Rudolph Hering, Peter Milne, D. McN. Stauffer. Each of the seven experts are members of the American Society of Civil Engineers, except Mr. Peter Milne, and he is Secretary of the American Water-Works Association.

It will be remembered by many that some of the city officials of Brooklyn, in December, 1890, contracted to buy these works for $1,250,000, but were enjoined from doing so. In 1892 the New York legislature passed an act providing for the appraisal of the works by the commission described above. The expert engineers for the company placed the value of the plant and franchise at over $2,000,000, while the majority of the commission, as stated above, valued it at $570,000.

Pneumatic caissons are to be used for the foundations of the high building which the Manhattan Life Insurance Co. is to erect at 64-68 Broadway, N. Y. The base of the structure will cover 67 ft. × 120 ft., and it is to have 16 full stories, with a tower. The foundations will be in fine, running sand, saturated with water, about 50 ft. deep to rock. Sixteen steel caissons, sunk by the pneumatic process, will probably be used, each caisson supporting two or four pillars, which in turn support the building. The caissons are to be sunk by Sooysmith & Co., of New York, and the work will be interesting as being the first application of this process to high buildings, to our knowledge, in this city.

The pig iron production for 1892, as returned by the American Iron & Steel Association, compares as follows, in gross tons:

	Total.	Charcoal pig.	Bitum. pig.	Anth. pig.
1892.....	9,157,000	537,621	6,822,286	1,797,113
1891.....	8,279,870	576,964	5,836,798	1,866,108
1890.....	9,202,703			

The stock on hand at the end of 1892 was only 506,116 gross tons; some 100,000 less than for the two preceding years.

The most serious railway accident of the week was a head collision Jan. 24 near Joliet, Ill., on the Atchison, Topeka & Santa Fe R. R. Two freight trains collided on the open track owing to a misunderstanding of train orders. Three men were killed and one was seriously injured.—A serious derailment occurred on the Chicago Great Western Ry., near Kent, Ill., Jan. 28. The train was an excursion, consisting of ten cars, and was ditched by a broken rail (according to report) and six cars went down the bank. One man was killed and nearly 40 injured, five or six seriously.

A freight train was derailed on the Newport News & Mississippi Valley R. R., near Big Clifty, Ky., Jan. 28, and three men were killed. The accident occurred at a switch.

A railway bridge accident at Peru, Ind., was noted, with report from the superintendent of the road, in our issue of Jan. 26, and we have since received the following particulars from a correspondent: "The derailment occurred about 150 ft. south of bridge on a curve, the last car turning over on the approach just before entering bridge, from what I can learn. The car fell toward the west, the derailment being toward that side, which was the outside of curve. The end post, however, on the south end of bridge on east side has the appearance of a severe blow—the plate and angles are broken and post bent almost double. The engine was about half its length on second span and was pulled back when bridge fell. From appearance the engine was on the track and when pulled back fell after bridge, landing on guard rail on west side. The 44 ft. of approach had 14 ft. ties, with double guard rail. On the bridge the ties are 10 ft. long, 8 × 8 ins. spaced about 13½ ins. centers, with a single 8 × 8-in. guard rail 14 ins. from rail. The ties on approach (that is what remained of them) are marked by wheels about 6 ins. from rail at the farthest. No rerailing device was used."

A reported trestle accident on the Iowa Central Ry. was noted in our issue of Jan. 26, but we learn from Mr. C. H. Eckert, General Manager, that there was not any failure of the trestle. The rear trucks of a passenger car left the track about 300 ft. west of the trestle, and when the car ran on to the trestle it went over the side of it. The trestle was not damaged in any way, more than a few broken ties. It was nothing more than a case of derailment at an unfortunate place, and, as yet, it has not been learned what caused the trucks to leave the track. The car was practically destroyed, and some six or seven passengers injured; two of them have since died.

The roofs of some of the large buildings of the World's Columbian Exposition have been damaged by snow, but the first reports are said to have been very much exaggerated. The weight of snow has had no effect on the trusses, but skylights and corrugated iron-work have been damaged by the weight and movement of the snow. The principal damage has been to the roofs of the Agricultural, Transportation and Manufactures buildings, but Mr. E. C. Shankland, Chief Engineer, is reported as stating that the latter can be repaired for $5,000. The damage will be made good by the contractors.

The proposed improvement of Buffalo Harbor, at an estimated cost of about $20,000,000, is still being energetically pushed by the South Buffalo Dock & Harbor Co. The location of the improvement would be next to the Tift Farm property of the Lehigh Valley R. R. Co., and adjoining the docks of that company. The plan calls for about 2,000 ft. concrete breakwater, extending out from Stony Point; a ship entrance, flanked by concrete walls; and four slips, each about 200 ft. wide, and running inland about 3,200 ft. The three piers between these slips would be each about 650 ft. wide, and be covered by railway tracks, connecting with the South Buffalo Terminal Co.'s tracks.

The ship channel connecting Baltimore Harbor with deep water in Chesapeake Bay was completed within the last year, after 40 years of more or less continuous work. Baltimore now has a channel 18 miles long, 600 ft. in width throughout and nowhere less than 27 ft. deep at mean low tide. This channel has only three angles in it and is widened out at these angles. The Baltimore Board of Trade, in its last report, says that for the existing liberal and comprehensive scheme and the final consumation of this work "we owe a debt of lasting gratitude" to Col. W. P. Craighill, Engineer Corps, U. S. A., the engineer officer who practically planned and for years was in charge of the execution of this public work. The same report also gives great credit to Major N. H. Hutton, Engineer of the Baltimore Harbor Board, for his assistance in this important improvement.

In Mr. Whinery's address on "Ethics for Engineers," published last week, the word "personal" should read "professional," near middle of middle column, page 78, making the sentence read: "Testify to alleged professional facts which contradict each other."

The Chicago Drainage Commission opened bids on Jan. 25 for $3,000,000 worth of work on the main drainage channel. This work includes the removal of about 7,200,000 cu. yds. of earth and 95,000 cu. yds. of rock, the building of 30,000 cu. yds. of retaining wall, and the dredging of 1,800,000 cu. yds. of earth from the Illinois and Michigan Canal. The prices bid ruled lower than those paid for work now under contract.

An association of road masters is in process of formation in Massachusetts, with the object of holding meetings once a month for the purpose of reading papers on road work and comparing experiences. Mr. W. E. McClintock, M. Am. Soc. C. E., a member of the State Highway Commission, is the prime mover in this project.

According to the last report of the Massachusetts Railroad Commission, the number of passengers carried on the street railways in that state exceeded the annual number carried on all the steam railways, for 1892, by 82,845,329. The total length of street railways, including branches, double-tracks and sidings, on Sept. 30, 1892, was 814.36 miles. Of this total 492.30 miles were operated by electric power, and the remainder by horse-power. As compared with the previous year, this shows an increase of 203.28 miles operated by electric power, and a decrease of 63.05 miles in lines equipped for horse-power only. All but one of the electric roads, the Milford & Hopedale storage system, use the trolley system. For the electric roads the total number of miles run was 29,617,975; the total passengers carried, 193,760,783; gross income, $9,817,537.35; gross expenses, $7,461,224.95. The average sum received for the conveyance of a passenger was 5.07 cts., and the average cost of carrying a passenger was 3.85 cts. On the 60 roads included in the report, there were 610 accidents, of which 26 were fatal. The West End, the largest system, was responsible for 300 of these accidents; and electric car accidents were 198 in all. On this line, 195 accidents occurred to passengers getting on or off the cars; 49 to persons on the street, and 56 by collision with vehicles.

Plans for a new dumping scow for garbage have been forwarded to Street Commissioner Brennan, of New York, by Com. George W. Melville, Chief of the Bureau of Steam Engineering, at the Navy Department. This scow would be 180 ft. long, 33 ft. beam, 9 ft. draft and 1,050 tons displacement. It is to be built of mild steel, propelled at an 8-knot speed by a compound engine of 500 HP., and will carry a load of 500 tons of garbage. This latter will be carried on an inclined deck, with an angle of 30° and 100 ft. long, and dumped by means of hinged doors operated from a central passageway. This boat could go to sea in any weather and to any desirable distance from shore, and she could break her way through the ice. Com. Melville has no financial interest whatever in this scow.

THE PHILADELPHIA & READING TERMINAL R. R. STATION, PHILADELPHIA, PA.

II.

(With inset.)

In our issue of Jan. 12, 1893, we published details of the main arch trusses and other ironwork for the roof of the Philadelphia & Reading Terminal R. R. trainshed, just opened for traffic, at Philadelphia, Pa. We show in the accompanying cuts and on our inset sheet this week complete details of the large horizontal wind truss at the Arch St. gable, and the general construction of the travelers used in erecting the roof arches.

Horizontal Wind Truss.—Owing to the fact that the trainshed abuts against the head house at one end, a system of horizontal wind bracing was required at but one end of the structure. The wind bracing at the head house end of the trainshed is, therefore, very simple, consisting of a system of lateral bracing between the first pair of arches connecting the end of each purlin with the opposite end of the one next above. A similar system of laterals was also used between the purlins connecting the first pair of arches at the opposite end of the trainshed in addition to the heavy horizontal wind truss. The intermediate arches had laterals between the upper side truss and the first purlin only. The horizontal wind truss runs longitudinally across the first roof arch at the Arch St. gable, on a level with the elbows of the arch. In Fig. 1 are shown the dimensions and arrangement of the various members composing the truss. From this it will be seen that at the ends where it connects with the arch it consists of a plate diaphragm, which passes between the two trusses composing the arch and is fastened to the diagonals of each. The truss proper consists of four chords connected by horizontal bracing and suspended from the roof arch by means of hangers. The two inner chords of the truss are parallel, while the two outer chords, starting from a conjunction with the inner chords at the ends, gradually curve outward toward the center of the truss. The truss is thus about 5 ft. wide at its ends, while at the center, it is about 16 ft. wide.

The wind truss is supported by hangers suspended from the main roof arch. Each hanger is composed of a vertical truss, which is riveted to the lower chord of the roof arch and carries at its bottom end a bracket which, in turn, is riveted to the chords of the wind truss.

Shop Construction.—Aside from the design of a structure of the magnitude of the Philadelphia & Reading Terminal R. R. trainshed, many of the most interesting and difficult problems occur in the shop construction and erection. As will be remembered, the individual chords of each panel of the arch trusses were required to be bent to conform to the true curve of the arch. This, of course, necessitated unusual care in the shop construction and assembling of the different members of the trusses. To do this the outline and details of the truss were first laid out with chalk on the floor of the company's template shop. The ironwork was made directly from the templates, the angles being bent cold to conform to their respective templates, while the web plates received their curvature while hot in the same manner as ship plates. Each piece was then marked off by template and the rivet holes punched, after which it was marked with its respective number and place it was to occupy. The next step was to assemble this mass of iron.

One-half of the arch was first laid out on the floor of the shop with an engineer's transit, and by the method of deflection angles. The problem was nothing more or less than that of laying out a railway curve, except that greater accuracy was required in turning off small angles and measuring off chords of 7 or 8 ft. The instrument was first set up over a point in the head of an iron pin driven into the shop floor at the panel point opposite the elbow of the arch. The angles were turned off and the chords measured, giving a point on the curve under each panel point. This was continued to a point half way around the curve, and then the angle was turned and the long chord measured, locating the center of the pin at the ridge of the arch. The instrument was then set up over this point, and the panel points located in a reverse order until the point half way around the half arch was again reached. This point determined from the two stations checked within 1-16 in.

The panel points having thus been determined, skids were placed about 8 ft. apart, and points on the curve of the chord marked off on them. Castings with hard wood blocks fastened to their faces were then bolted fast to the skids so that the top chord of the truss could be clamped to them, and the exact position of the whole line of the arch determined. The bottom chord pieces were then laid on the skids approximately in position and brought into their exact places by means of the diagonal members. After the whole half arch truss was thus laid out, the pin center was marked and all reaming done in position. Enough rivets were driven by hand to fasten the members of each section together, and then the sections were separated from each other, and the riveting on each completed by power.

Erection.—The facilities for erection consisted briefly of a false work built up of wooden bents so as to act as a centering for the arch, and a traveler by which the iron sections were manipulated. The false work centering was carried on trucks, which ran on tracks parallel to the length of the trainshed. This permitted the movement of the centering from arch to arch. The traveler was provided with a movement at right angles to that of the centering by means of trucks running on a track laid on a platform carried by the trucks carrying the centering. The structure was thus capable of movement in two directions, allowing of the quick and convenient placing of the different members. The traveler was provided with an arm of sufficient length to span two of the arches. The hoisting engines and a ballast of rails were placed at the base of the travelers to counterbalance the rotating effect produced by the overhanging arm of the traveler. Details of the false work centering and the traveler are shown on the inset sheet.

The method of operating the centering and traveler was as follows: The sections of the arch trusses were erected in pairs and braced together as fast as erected. This was continued until the crown was reached, when the pin was driven connecting the two half arches and completing the whole arch of 259 ft. The purlins and jackrafters were then set in place. The time required to move the false work was about 40 minutes.

The contract for the ironwork and the erection of the trainshed was let to the Phoenix Bridge Co., of Phoenixville, Pa., and the details of the travelers and method of erection were designed by the company's engineers. The station and trainshed were designed by Wilson Bros. & Co., of Philadelphia, Pa.

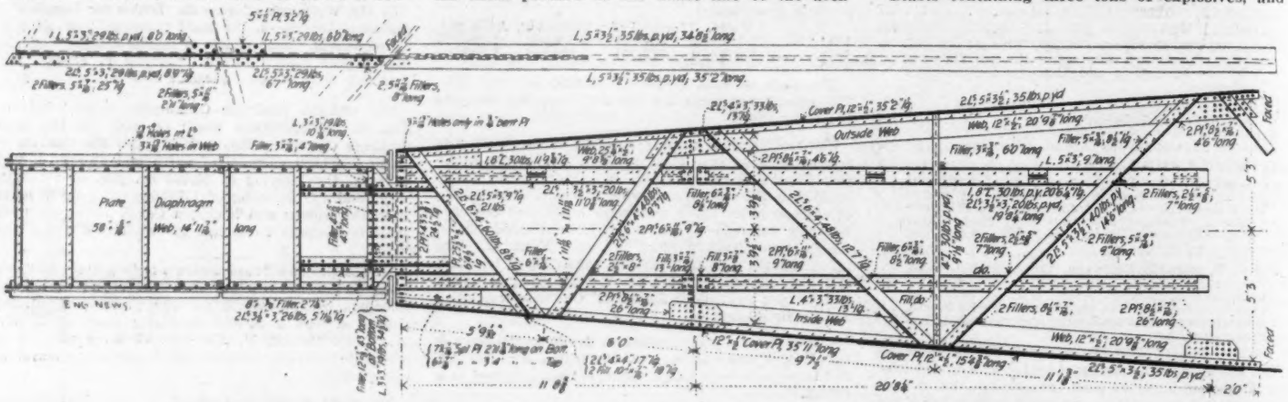


FIG. 1.—DETAILS OF HORIZONTAL WIND TRUSS; PHILADELPHIA & READING TERMINAL R. R. TRAINSHED.

HEAVY ROCK BLASTING.

In quarrying stone for the Westport harbor works, New Zealand, the charges used were carefully considered, says Mr. John Alexander Wilson, in a paper read before the Institution of Civil Engineers. The stone used was granite, gneiss and limestone, in large blocks. To obtain these cheaply large blasts were employed, and the rock varied from bedded and jointed gneiss to homogeneous masses of granite. On an average one pound of dynamite dislodged ten tons of stone, and the total amount of a charge was usually decided on this basis. The separate charges were proportioned in the ratio of the cubes of their least resistance, and this L. R. was divided by 35 for dynamite, 36 for gelegnite, 43 for gelatine dynamite, 50 for blasting gelatine and 12 for blasting powder.

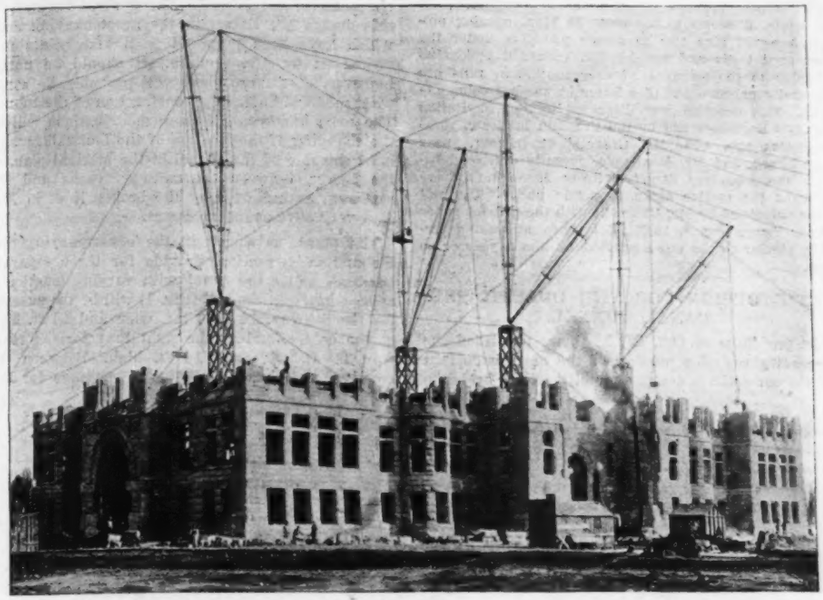
Blasts containing three tons of explosives, and another of seven tons, were each failures, as they broke up the rock too much. It was found that charges of from ¼ ton to 1½ tons were the most useful, and this class of blasting hardly answers with a line of least resistance exceeding 40 ft. Beyond that the elasticity of the rock along this line becomes so great for the resistance of the back-off which the charge works, and instead of throwing the front out, the explosion may merely develop an undulating motion radiating from the charge.

The best results were obtained where the rock had one or more loose ends with a nearly vertical face; a strong toe at the quarry floor-level was usually first removed by hand blasting before firing the large shot. The length of the adit was made as nearly half the height overhead as practicable; while the most even results were obtained if 15 multiplied by the least resistance was adopted for the interval between the chambers, and even less with irregularly shaped blasts.

A national harbor of refuge, authorized by Congress on July 13, 1892, is to be constructed at Point Judith, R. I., under the charge of Capt. Wm. H. Bixby, Corps of Engineers, U. S. Army, Newport, R. I. The total estimated cost is $1,034,000, but only $66,000 has as yet been appropriated, and further payments and progress will be dependent upon future appropriations. The work to be done is the building of a rough stone breakwater. Bids are invited up to Feb. 24, with the understanding that only the above named $66,000 is now available. Each bid must be guaranteed by two responsible guarantors in the sum of $120,00 each, and the successful bidder must give a bond of $120,000. Work must commence not later than May 1, and be as continuous as the weather permits.

THE CROSBY TUBULAR IRON DERRICK.

In the erection of large buildings and other structures, derricks play a very important part, and for contractors who undertake work in various parts of the country, necessitating frequent shipment of plant, there are special advantages of durability and portability in the iron derricks which are now being used to some extent. The accompanying illustration represents the use of



CROSBY TUBULAR IRON DERRICKS USED IN ERECTION OF COURT HOUSE AT SALT LAKE CITY, UTAH.

the Crosby tubular iron derrick in the erection of the court house and county building at Salt Lake City. There are four derricks, arranged as shown on the small plan. Each derrick stands on a pedestal made of timber, which brings the foot of the derrick 40 ft. above the ground. The masts are 80 ft. long and the booms 75 ft., each derrick therefore handling all material within a circle of 150 ft., and the four derricks completely covering the building, which is 300 ft. long by 140 ft. wide. Being set upon these pedestals, the derricks will not be moved until the building, which is five stories high, is completed. The two lines operating the mast and boom pass through the foot of the derrick down through the pedestal or 40-ft. tower to the hoisting engine. The derricks can also be rigged so that the mast and boom are revolved by the engine, but this arrangement is not applied to the derricks in this particular work. These derricks are said to have repeatedly handled 5-ton loads with apparent ease.

The Crosby tubular derrick, as used in the construction of the Central Presbyterian Church at Denver, Col., was illustrated in our issue of Nov. 28, 1891, and the Norcross skeleton iron derrick, as used in the construction of the Equitable Building, at Denver, Col., was illustrated in our issue of Aug. 22, 1891. The Crosby derricks used at Salt Lake City are readily taken apart and can be packed in a box car, the largest pieces being 20 ft. long, while the masts and booms of large timber derricks sometimes have to be loaded on two or three flat cars. The manufacturers test each boom and mast before shipment by supporting the ends while in a horizontal position, and loading the center with 3,000 lbs., which is much in excess of the strains the members will be called upon to sustain in actual work. These patent derricks are made by the American Hoist & Derrick Co., of St. Paul, Minn., and were designed by Mr. Oliver Crosby, president of the company.

TRACK FOR HIGH SPEEDS.

The question of high speeds on railways was discussed in our issues of Dec. 8 and 22, 1892, in connection with the fast run between Philadelphia and New York, over the Philadelphia & Reading R. R. and Central R. R. of New Jersey, during which two miles were made in 37 and 38 seconds, or at the rates of 97.3 and 94.7 miles per hour. We give below an abstract of a paper by Mr. Charles S. Churchill, Engineer of Maintenance of Way of the Norfolk & Western R. R., read before the Engineers' Club of Philadelphia, Dec. 3, dealing particularly with construction of roadbed and track for the operation of traffic at high speeds. He considers that the engines for such traffic will be considerably heavier than any now in service, but this does not seem to be substantiated by the evidence afforded by the fast trains noted in our issues above referred to.

Grades.—A locomotive with power to run at a speed of 100 miles per hour on a level and straight track would be reduced by a grade of 20 ft. to the mile to a speed of 80 miles an hour, and more than 30 ft. grade would bring the speed down to that reached on our present trunk lines. Grades should, therefore, be fixed at 20 ft. per mile, with a possibility of 30 ft. per mile in exceptional cases.

Curvature.—The addition of a 1° curve to a line adds resistance equivalent to a grade of 2 ft. per mile, and the resistance increases as the curves are sharpened. We cannot get along without curves, but they should be made as small as possible, and the grades reduced at the rate of .04% per degree of curve. Speed, however, is very greatly limited by the sharpness of curves, which causes danger from centrifugal force to the body of the car, and loss of time with rough riding. A 5° curve probably causes 50% more wear to the rails than is produced on a tangent, and if a speed approaching 100 miles per hour is to be maintained, curves should seldom be used sharper than 1°, and never sharper than 2°.

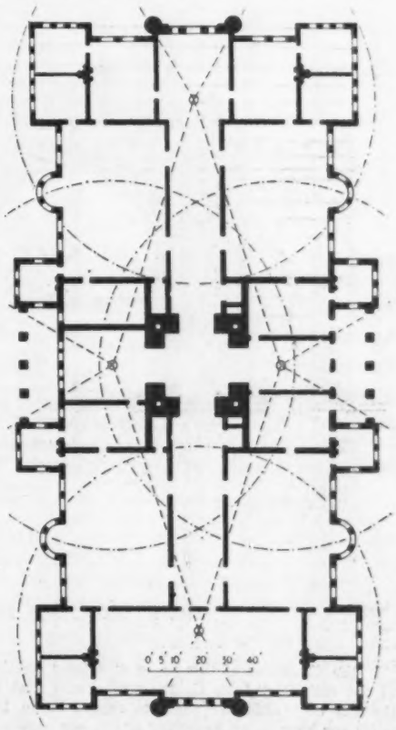
Roadbed.—The adoption of slight grades and curvature will cause heavy work in constructing the road. Even now for high-speed service four tracks are necessary, and the line requiring a speed as great as 80 to 100 miles per hour would furnish a large passenger and freight business, and the former must be kept on tracks separate from the latter. A four-track railway will then be necessary, the freight being handled on the outside tracks. Tracks should be spaced at least 13 ft. c. to c., with ditches outside at least 7 ft. from the edge of the rails. Slopes of cuts and fills should be 1½ to 1, and all earth cuts thoroughly sodded. Rock cuts should be taken out at a slope of ½ to 1 and thoroughly cleared of loose material. Berm ditches should be provided at the top of all cuts. The roadbed under passenger tracks should be tile drained. The edge of the roadbed should be limited by a line 7 ft. from the outer rail of the freight tracks. Box or arch culverts should be provided, laid in good cement, and of ample size to care for the watersheds. No road, highway or street should be crossed at grade, as it would be practically impossible to give the necessary warning, or to check the speed at each crossing. All of the right of way should be substantially fenced, the posts being not farther apart than 8 ft.

Bridges.—Drawbridges should be avoided by careful location. Grades should be arranged with a view to using stone arches wherever possible, and they are about as cheap as girder bridges to carry rolling loads, such as are now required. If stone arches are impossible, plate girder bridges, with buckle plate floors, should be used up to a span of 100 ft., riveted trusses up to 120 ft. span, and pin connected trusses for greater spans, all with buckle plate floors.

Ballast.—Broken limestone or trap should be used if possible, though sandstone or carefully selected slag will produce good track. The thickness of the ballast should not be less than 12 ins. under the tie at the center of each track, and the stone should be broken to pass through a 2½ in. ring.

Track.—The ties should be white oak, hewed, 7 × 7 ins., and 8½ ft. long. Not less than 2,800 ties should be used to the mile. For the necessarily heavier train, the track must be rigid but not inelastic. The rails should weigh 100 lbs. per yd. with a good height and a wide base; for example, a rail 5¾ ins. high, with a 5¾ ins. base and a head 2¾ ins. wide. About 25% of the accidents at present occurring are due to bad track, and at least 2% to the joints themselves. Mills are now able to produce rails in 60 ft. lengths, and an expansion of ½-in. is sufficient for such a rail, provided a secure joint is furnished. Smooth riding track will be secured by adopting the miter joint (technically known as the Sayre joint), the rail being cut at an angle of 45°. This has been used on the Lehigh Valley R. R. for ten years past with great success.

The form of splice is a matter of great importance. The fish-plate type is defective in principle, and will undoubtedly be displaced within a few years, even



Plan of Salt Lake City Court House, Showing Range of Derricks.

with the present speeds. The rail should be supported at the joint from beneath, as well as at the head, and the joint should be as strong as the balance of the rail. Rail spikes form a very insecure fastening, and the interlocking bolt seems to be the simplest device for securing an effective and rigid contact of the rail with the ties.

Only by combining all of the above requirements will a comparatively smooth and safe riding track be produced without undue resistance to trains. The rails must be truly level on tangents, and the outer rails on curves of 1° to 2° should be elevated 5 ins. above the inner rail, by raising the former and depressing the latter each half this amount. Across through-bridges the tracks should be protected by inside guard rails 7 ins. from the main rail. Switches should be as few as possible, and the best pattern of point switch seems to be the most desirable. Spring rail frogs would be best from our present point of view, and should be of improved pattern, built on a ¾-in. plate, the wing rail having the spring near the end, with a lever to hold it in position, the top being beveled to prevent a possible forcing open of the wing rail by badly-worn engine

tires. Distant signals should be placed so that even at these high speeds a train could be stopped before reaching the switch.

Protection of Track.—Tracks should be constantly patrolled, and an interlocking system of signals, perhaps preferably an electric one, will be found necessary for proper protection. The possible running of trains at such high speeds depends to a large extent upon the ability of engineers to provide proper protection. Whether speeds of 80 to 100 miles per hour will be secured or not in a few years, it is certain that the present tendency is to constantly introduce heavier locomotive and rolling stock, and to use high speeds. It is the engineer's duty, therefore, to make his recommendations and plans so that the road may be safe for such traffic, and only those roads that are built or improved as above outlined will be able to meet these requirements.

No existing road, at least in this country, fulfills them to-day, and speeds of 80 to 100 miles per hour could not now be used. Comparatively few of our trunk lines, from the nature of the country traversed, could be brought up to this condition, and it is improbable that a new four-track railway will be built especially for such high-speed service; hence portions of existing lines in suitable sections of the country must be regarded as the only roads which may in time develop an increase over present speeds. Such sections having been improved in grade and alinement, a locomotive capable of hauling a train on a straight and level track, at the rate of 100 miles per hour, may make, on a properly protected line, an average speed of from 70 to 80 miles per hour.

cross-ties, I am surprised to find that Mr. Churchill specifies a quantity of wood per mile but little, if any, greater than that now in use, and this with a diminished width of tie. As to rails, with curvature limited to 1° and 2°, as Mr. Churchill proposes, his 100-lb. rails might, perhaps, be found sufficiently heavy for the increased weights and speeds. Otherwise, since with a given radius the centrifugal force is proportional to the weight of the train and to the square of its speed, we would propose that so slight an advance upon present practice would be found insufficient. As to joints, it seems to me that the ¼-in. opening proposed would give rise to severe pounding under the increased loads and speeds. Mr. Churchill makes no allusion to the question whether continuous rails are generally practicable. (See letter in another column.—Ed.). This question was discussed by the Institution of Civil Engineers and by the Franklin Institute, some 40 years ago, and Mr. Gleaves' experiment, near Lynchburg, and Mr. Moxham's, recently described before the American Street Railway Association, have brought the matter again to public notice. The rail joint submitted by Mr. Churchill with the present paper (Eng. News, Dec. 8, 1892) is, I think, at least generally, similar to the one described by him a year or so ago.

PRIZE DESIGN FOR THE DULUTH SHIP CANAL TUNNEL.

In our issue of Oct. 27, 1890, we published the general plans of a number of the more important of the competitive designs submitted for a bridge to

be cheapness of construction, durability and adaptability to the location. Twenty-three designs were received and examined by the Board of Public Works and its consulting engineer, Mr. Samuel G. Artingstall, of Chicago, and it was decided to award the prize to the design submitted by Mr. C. C. Conklin, of Scranton, Pa., which was considered to best comply with all the requirements, and to be eminently adapted to the location and the character of the ground. The general features of this design are shown in the accompanying cuts, which have been prepared from blue prints furnished us by Mr. Conklin. It should be noted, however, that these plans will probably be somewhat modified before the construction of the tunnel. The most important of these modifications will be the changing of the location of the footwalk, which is at one side of the tunnel in the original plan, to the center, between the railway tracks and the roadway, as indicated by the broken lines in Fig. 1., a very obvious improvement.

The plans, as shown in the accompanying profile and cross section, provide for three separate passages under the canal with varying lengths of approaches. At the left (Fig. 1) will be the passage for the railway, 14 ft. 6 ins. wide and 18 ft. high at the center, and at the right that for the roadway, 20 ft. wide and 14 ft. high. Between the roadway and railway will be the passage for the

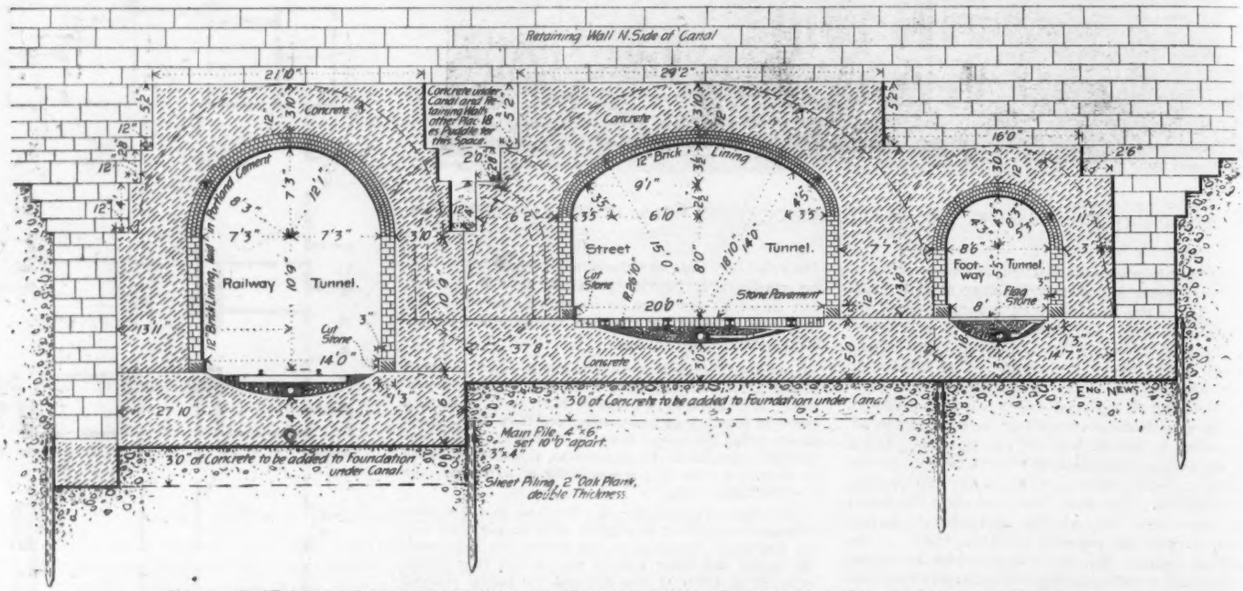


FIG. 1. SECTION OF PROPOSED TUNNEL UNDER SHIP CANAL AT DULUTH, MINN.; C. C. Conklin, Designer.

In the discussion of this paper at a later meeting of the club, Mr. John C. Trautwine said that he thought that when we came to regard 80 to 100 miles per hour as an everyday affair, our cars will be suspended from rather than supported by the rails, and that heavy trains will be replaced by single, light vehicles running at short intervals. In discussing more particularly the ordinary track for high speeds, as described in the paper. Mr. Trautwine made the following remarks:

As to grades, it appears to me that if, in the future, we are to submit to the same variation of speed as now, no material change in grade will be required; for the matter of grades applies rather to uniformity of speed than to the speed itself. Again, if in order to maintain uniform a high rate of speed we improve the grades by lengthening the line, we may thus offset the advantage due to the gain in speed. As to curvature, so little is known respecting the relation between curvature and speed that we think it is only by guess-work that we can fix, in advance, the limit of curvature or the amount of superelevation required for these high speeds. Certainly, however, as Mr. Churchill says, such speeds will demand a lengthening of radii.

As to draw-bridges, it is difficult to see how these could, in all cases, be avoided, however careful the location. Here, too, a long detour may involve as great a delay as would be entailed by the draw. As to

connect the main business portion of the city of Duluth, Minn., and the rapidly growing district on Minnesota Point, which are now separated by the ship canal, 250 ft. wide, running across the Point. As, however, the Federal government refused to allow the construction of a bridge the city recently

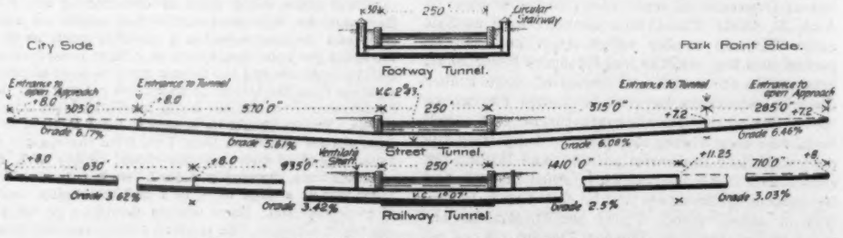


FIG. 2. PROFILES OF TUNNEL UNDER SHIP CANAL.

advertised for designs for a tunnel under the canal, offering a prize of $1,000 for the best plan submitted. The conditions of the competition required the tunnel to provide for railway and street railway tracks, a roadway and a footwalk, and stated that the principal features of the plans submitted, which would be considered above all others, would

foot walk, 8 ft. wide and 9 ft. 8 ins. high. The various other dimensions are shown in the illustration. The approach to the railway tunnel (Fig. 2), on the city side, is 1,565 ft. long, 630 ft. of which is an open cut, with a concrete base made with an invert underneath the track and forming the foundations for the concrete retaining walls, and 935 ft. is closed. The grade of the track in the approach will be 3.62%. The tunnel proper under the canal will be 250 ft. long, with a vertical curve of 1° 7'. On the Park Point side the closed approach of the railway tunnel will be 1,410 ft. long, with a grade of 2.5%, and the cut 710 ft. long, with

a grade of 3.03%. The roadway tunnel, on the city side, will have an open cut, 305 ft. long, with a grade of 6.17%, and a closed approach 570 ft. long, with a grade of 5.61%. The section under the canal will have a vertical curve of 2° 43'. On the Park Point side the closed approach is 815 ft. long, with a 6.08% grade, and the open cut 285 ft. long, with a 6.46% grade. The passage for the foot-walk will be only about 60 ft. longer than the width of the canal, and will connect at each end with a shaft carrying a spiral stairway, by which the street level is reached.

As will be seen from the illustrations, the tunnel is essentially a concrete structure, advantage being taken of the large amount of sand and gravel on the site. The approaches are to be constructed in an open trench, to be excavated from the surface, and the tunnel proper under the canal by means of a coffer-dam, only one-half of the canal being closed at a time. The foundations, sides and arches of all three tunnels are to be built of concrete and lined with brick, 12 ins. thick, laid in cement in the closed approaches, and in concrete underneath the canal. At the outer lines of the foundations, rows of sheet piling 12 ft. long are to be driven, and the sand thoroughly rolled and packed, and the concrete laid on the sand, working from the bottom up. The brick arches are to be laid on a timber centering.

The costs of the various classes of work, as estimated by the designer and by Mr. Artingstall, are as follows:

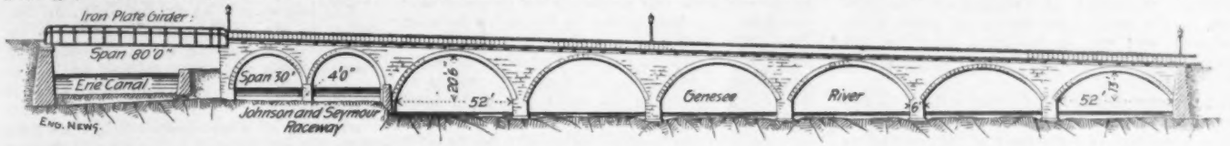
	Conklin.	Artingstall.
Excavation	$75,000	$80,000
Concrete	336,000	407,000
Masonry	133,000	112,000
Brickwork	77,000	45,000
Coffer-dam	16,000	40,000
Drainage	5,000	3,000
Sheathing and bracing	.....	10,000
Rock filling	8,800	.....
Side walks	.....	1,000
Paving	5,000	12,000
Stairways	8,000	15,000
Sundries	20,000	.....
Total	$683,800	$705,000

NEW STONE ARCH BRIDGES AT ROCHESTER, N. Y.

We show in the accompanying cuts the general plans of the two stone arch bridges to carry Court and Andrews Sts, over the Genesee River, at Rochester, N. Y., the contracts for which have just been let, as noted elsewhere in this issue. Both of these bridges replace old structures, and were designed by Mr. J. Y. McClintock, City Surveyor, Rochester, N. Y., to whom we are indebted for the matter from which the illustrations were prepared.

The Court St. bridge consists of eight stone arch spans and one plate girder span. Six of the arches have spans of 52 ft. each, and rises varying from 13 ft. to 20 ft. 6 ins., the difference in rise providing for the grade of the roadway; and the two other arches have spans of 30 ft. each. They are supported by masonry piers and abutments resting on bedrock. The plate girder span is 80 ft. long. All the masonry of the piers and spandrel walls is to be first class. The spandrel backing will be of concrete and the spandrel filling of gravel carefully packed. The total width of the bridge is 64 ft., divided into a roadway 40 ft. wide, and two sidewalks each 12 ft. wide. The paving of the roadway will be Medina sandstone blocks laid on 6 ins. of concrete, and that of the sidewalks 2 ins. of asphalt on 6 ins. of concrete. The contract price for the bridge complete, including grading the approaches and removing the old bridge, was $137,931. Excluding the plate girder span, this is $295 per lin. ft., and including the plate girder span about $275 per lin. ft.

The Andrews St. bridge consists of six stone arches of 34.43 ft. span, and 9 ft. rise, and one arch of 32.43 ft. span and 8 ft. rise, and is 60 ft. wide. The masonry, paving, etc., are practically the same as for the Court St. bridge. The contract price for the bridge was $72,537, or $254 per lin. ft. Detail prices of the different classes of work for both this bridge and the Court St. bridge will be found on another page.



COURT ST. STONE ARCH BRIDGE, ROCHESTER, N. Y.; J. Y. McClintock, Chief Engineer.

ANDREWS ST. STONE ARCH BRIDGE.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XL.

The Subsequent Employments of Engineering Graduates.

The attractiveness of engineering as a profession is greatly increased by the opportunities which it offers from diverging from the strict line of professional work into other and (generally) more lucrative occupations for which engineering training and practice are an excellent preparation. This results from the fact that engineering is a practical and creative profession, in broad distinction from the three older professions, medicine, law and theology, which, at most, are only negatively creative, in preventing the destruction which would otherwise result from men's vices and follies. Accordingly, the trained physician or the theologian is rather debarred by his training from success in any other calling than fitted for it. They rarely diverge from the strict line of professional work after once entering upon it, and almost never with success. The law is more fortunate, since many lawyers do become fitted for highly responsible positions at the head of certain kinds of large corporations, while they almost monopolize the political field. But still, it remains true that, if those who merely enter law as a stepping stone to political life be excepted, the number of those who abandon the law for other occupations with success is but a trifling percentage of the whole, though the exceptions are often striking and important.

But in engineering it is rather the rule than the exception for the successful men to be finally tempted out of strictly professional work to become managing officers of public or private corporations, contractors, or founders of industrial enterprises. No statistics gathered now or for many years to come can adequately represent this tendency, for the reason that most of our engineering schools are so young that they have had very few graduates of more than 20 years' standing, and it is only after long professional practice, as a rule, that the opportunities we have spoken of come to engineers.

Nevertheless, the following statistics (Table XXXV.) for 19 different colleges, covering 2,738 different graduates, most of them of very recent date, are significant in this respect. They show that only 54% of these graduates were adhering strictly to professional work in 1890, whereas 16.5% were engaged in three other specified occupations, and 29.5% were engaged in "other" occupations, for the most part of a similar nature.

To show how greatly the age of the graduates affects this position, more than one-quarter of the graduates are from a single institution, the "R. P. I." the oldest college in the list. Of its 738 graduates only 43.3% are reported as in engineering practice, while of the remaining 2,000 graduates, 57.9% are so engaged.

Moreover, the real number who have diverged from professional work is considerably greater than appears on the face of the returns, because of a fact which speaks well for the profession, that men are reluctant to confess that they have left it after they have done so partially or wholly. They still cling to the title of engineer and report themselves as such so long as they can retain any shadow of title for doing so, after their principal and supporting occupation has become that of manager, manufacturer, contractor or builder, real-estate operator, etc., etc.

Table XXXV.

Names of Institution.	Present Occupation of Graduates of 19 Engineering Schools. Engineering practice.	Railway officers.	Managers of works.	Contractors.	All other occupations.
Rens. Pol. Inst.	320	53	37	3	323
Mass. Inst. Tech.	280	65	50	5	125
Cornell Univ.	172	56	46	32	22
Lawr'c. Sc., Harv.	40	5	11	10	48
Thay. Sch'l (Dart.).	36	...	...	1	6
Wash. U., St. Lo'is.	65	3	8	2	20
Univ., Pa.	106	...	1	...	44
Rose Pol. Inst.	25	...	1	...	20
Union Univ.	125	8	10	1	54
Univ., Ill.	90	...	...	...	10
Univ., Wis.	87	...	...	...	17
Univ., Minn.	26	...	3	...	6
Univ., Iowa	30	...	...	...	11
Tufts Col.	45	6	8	7	4
Univ., Ga.	46	3	...	...	35
Swarthmore Col.	23	1	5	...	28
Cornell Col., Ia.	16	...	...	...	25
Univ., Neb.	6	...	2	...	4
Mich., Agri. Col.	10	...	2	...	6
Totals	1,478	200	193	61	806
P. c.	54.0	7.3	7.0	2.2	29.5

The time has not seemed ripe for attempting to gather any complete statistics on this head; there will be difficulties in ever doing so. But it is one of the important factors which must be considered by every young man when choosing his profession, because the openings of this kind for technically trained engineers have been for years increasing, and will for years continue to increase. Moreover, there is no use disguising the fact that it will even have a tendency to keep down the ruling rates of compensation in strictly professional practice; because it is inevitable that, in the lottery of life, those professions which offer most prizes will be most chosen, and the rates of compensation in all ranks below the top of every profession will inevitably be determined by the number of men seeking positions at the top. This is especially true if a profession offers, as does engineering, specially tempting baits to those just entering upon it. No other profession known to man offers such easy, abundant and well paid employment to the young graduate and young practitioner as does engineering. Hence it is especially attractive to many poor young men, and after they are once in, it is hard for them to change their plans of life. They tend to stick to it in spite of discouragements.

Value of Plant and Buildings of Engineering Schools.

We have tolerably full, yet far from complete, reports on this head. We have determined to give none of it in these articles; for the simple reason that we think it would be in too many cases, and for a variety of reasons, misleading information. The increase is rapid at all our leading engineering schools, and all but three or four are still deficient in this respect. It is more than pardonable that they should be so, for engineering education is enormously expensive in the way of plant, compared with any other kind of instruction whatever, and most of our schools are still so young that they have not had time to accumulate all the plant which they really should have. The relative value of such plant for educational purposes,

moreover, is rather as the cube root of the sum invested in it than in direct ratio therewith; i. e., it requires fully eight times as great cost of experimental and laboratory plant to double the value of the instruction given from it. Every good engineering school must and will have the best that can be had, nevertheless, for it is a still smaller difference in weight of acquirements, in most cases, which makes the difference between the successful and the unsuccessful man; but the temporary deficiencies of any school should not be held up against it.

The descriptive portion of these articles is now concluded. It remains only to give, in a concluding article, somewhat of a summary of the conclusions which this investigation seems to indicate in respect to our engineering schools.

A number of colleges have sent us marked copies of their catalogues, calling attention to certain changes which they have asked to have embodied in the reprint of these articles. From these and other signs we judge that this is a period of very rapid change in engineering schools. It will, as a rule, be impossible for us to accede to these requests, however, first, because we have studiously refrained from trusting to our understanding of catalogues, preferring to obtain the information direct in the form in which it was to be used, and secondly, because we cannot give the time to it.

Tufts College makes a change this year from a three-year to a four-year course. We cannot doubt that the few remaining three-year colleges will soon adopt the same course, or be left in a very lonely position. Tufts has also changed its degrees to B. C. E. and B. E. E. It has no purely mechanical course. Its year, if we have counted it correctly, consists of 37 weeks, with 15 weeks of vacation in all.

The Worcester Polytechnic School will also lengthen all its engineering courses this year from 3½ to 4 years. These two changes leave Yale almost alone in its three-year course, starting from the usual requirements for admission.

Vanderbilt University, we regret to say, has not been duly represented in these columns, and it is alleged by our fault, inasmuch as it is alleged that full information was sent us on the blanks first sent out. We have no such blanks, and no evidence that we ever received any. We the more regret this omission because this university enjoys and deserves an honorable place in the list of our engineering schools, both for its actual achievements and its promise of further advance.

Cornell University will, on and after June, 1894, demand at entrance another full year of mathematical works, so that it may start in with calculus in the freshman year and put applied mechanics into the sophomore year. This change is in the direction in which many colleges are moving, and all should move as fast as circumstances permit, but few have, as yet, gone quite as far as this.

The Stevens Institute, which has a full 40-week year, furnishes us with the following result of a canvass of their present senior and junior class, as to the number who obtain paid vacation work:

	Juniors.	Seniors.
Drafting	2	2
Office work	3	.
Machine shop work	6	5
Tutoring	7	.
Carpenter work	2	.
Daily paper reporting	1	.
Total	21	7

The size of the respective classes is not stated, but the graduating class of late has been about 40. From this it would appear that a large part of the students, possibly all those who have any pecuniary need for employment, are able to secure it in spite of the short vacations of the school, and with hardly an exception in lines giving them profitable experience.

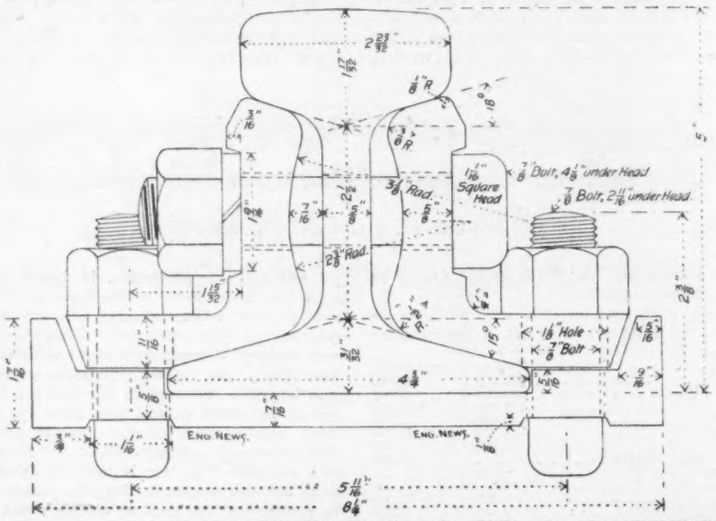
THE DELANO RAIL JOINT; CHICAGO, BURLINGTON & QUINCY R. R.

While a certain degree of unanimity has been arrived at in regard to the form of rail sections, there is still a very wide diversity of opinion as to the best form of rail joint, and new devices are constantly being added to the large number of joints already in service. Some important roads still use suspended angle-bar joints, while others use three-tie joints, with long angle bars, the middle tie supporting the ends of the rail, but there appears to be a growing opinion in favor of some form of bridge joint, supporting the base of the rail for some distance back from the end, and distributing the weight over the joint ties. In some cases, however, while a base support is given to the rail ends, this support is not extended over the joint ties, but limited to the space between them. The Fisher joint is one of the best known forms of bridge joint, but Mr. Fisher considers the base support sufficient, and does not approve of supporting the rail by the under side of the head as is done by the use of splice bars. We illustrate this week a form of joint combining a bridge plate and splice bars, which was designed by Mr. F. A. Delano, Superintendent of Freight Terminals of the Chicago, Burlington & Quincy R. R., who is well known in connection with matters relating to rails and track generally. The joint is shown as applied to Mr. Delano's 85-lb. rail section, and is reported as having given entire satisfaction after almost two years' service. In general principle the joint somewhat resembles the "triple-fish" joint illustrated in our issue of Aug. 25, 1892, but has the usual splice bar bearing under the head of the rail, and two single base bolts instead of the three U-bolts of the "triple-fish" joint, while the latter has no bridge resting upon the ties. Mr. Delano writes as follows respecting his joint:

I note in your issue of Dec. 1, 1892, that there was recently a meeting at Chattanooga of the Roadmasters' Association of America, at which the Committee on Rail Joints made an important report of progress regarding its investigations. I am glad to note that there seems to be a strong disposition to recommend a joint which will give the rail support from beneath in addition to a simple support under the head. This to my mind indicates a decided advance, for at the Roadmasters' convention at Denver in September, 1889, a similar committee reported in favor of a long angle-bar three-tie joint. At that meeting Mr. I. Burnett, who was then vice-president of the association, read a letter I had written to him under date of Sept. 4, 1889, bearing on the subject of the requirements of a perfect rail joint (Eng. News., Dec. 28, 1889). In that letter I described a joint which has since then been manufactured and put into experimental use on the Chicago, Burlington & Quincy R. R., and this joint has thus far given such entire satisfaction that I think the engineering profession may be interested to know more of it. Some of the track laid with this joint was laid with joints opposite, while some of it was laid with broken or alternate joints with short 5-in. angle-bars in the center of the rail opposite the joint, acting as an additional anchorage for the rail. This track of 85-lb. rail thus laid is really a fine specimen of good and substantial track, and I think I may safely say that all who have had anything to do with the joint think it at least fully as good as any joint before tried, while some are willing to say much more. The joint certainly has the merits of simplicity and a by no means excessive first cost. In fact the joints were bought in a comparatively small quantity for $1.30 per joint complete, which is decidedly less than is paid for 40 to 48 in. angle-bar joints. The fact that this joint has given such good satisfaction may be fairly considered as due to its having been designed to meet the requirements of the perfect rail joint, and these requirements were very clearly explained in an editorial article in your issue of Dec. 28, 1889, on page 605. So far as I know, this joint has not been tried on other roads, but any one desiring to try it is welcome to do so, and I should be pleased to hear of the results of experiments with it.

The following is an extract from Mr. Delano's letter to Mr. I. Burnett, Vice-President of the Roadmaster's Association of America, written Sept. 4, 1889, and above referred to, in which he concisely presents his views upon the point in question:

Balancing all these considerations, I am inclined to think that the perfect joint has yet to be devised, and it is not certain that anything had been produced to excel the angle bar in certain forms. For light railways, such as a greater portion of the mileage covering the prairie country; I am inclined to think that the angle-bar joint will be always used; and the kind I should favor is the shortest four-bolt angle bar that can be used to cover three ties, huddling the ties at the joint as close as is possible for good tamping, on the principle that the joint cannot be held up, no matter how good the fastening, unless the foundation is there to hold it. In connection with this I may say that I have recently recommended the use of a 32-in. splice bar, with four bolts, to be used as a three-tie joint, setting the shoulder ties 15 to 16 ins. c. to c. from the joint tie. On single track this sort of joint should be laid broken jointed, but on double track square jointed, unless the ballast is extra good, or a short piece of angle bar is bolted in the center of the rail to prevent the skewing around of the ties. From what has gone before it will not be supposed that I consider such a joint perfection, but rather that it is suggested as possibly the best kind of joint for light rail and cheap lines doing a light traffic at starvation rates.



CROSS-SECTION OF DELANO 85-LB. RAIL AND DELANO RAIL JOINT; CHICAGO, BURLINGTON & QUINCY R. R.

For main line use where the traffic is heavy, I think that the angle bar joint will have to be either displaced altogether or reinforced in some way. If the rail is not to be held up by its "shoulders," it must be by placing the support under the broad, flat base; yet, as soon as we do this we meet the difficulty of making the device very unhandy and cumbersome. Many joints have been produced, some of which show great ingenuity, but the best of these have not been tested long enough to demonstrate their value. Besides this, as rail joints are now being invented at a rate which is truly astonishing, and possibly never eclipsed, except by automatic car coupler devices, there is hope that the key note will be struck sooner or later. I am watching experiments on some of these joints which have seemed to give promise of success with a good deal of interest, but if bad comes to worse, and nothing else is found, I shall be disposed to try a combination of the two principles, the angle bar and the base plate. For example, use a rolled plate, seven to eight inches wide, covering two ties, flat on the bottom and recessed on the top with a shallow channel, which shall just admit the base of the rail, then in addition to this, use a short 12-in. two-hole angle bar with broad flange which will permit one short bolt on each side (staggered in relation to the rails) to be put to fasten it and the base plate through its thickened edges.

I should not be surprised to see some such com-

promise as this adopted after a few years of trying patented devices. The fault of the angle bars, more particularly in the suspended joint, lies in the fact that they need constant and unceasing attention to give good service. If for any cause the joints get low and are left so, the angle bar becomes nicked or bent, and after that no amount of attention will make it a perfect joint. It is then that the usefulness of the joint tie, in the supported joint, or of the subplate, in the joint I have described, is evident. So long as the ends of the rails are supported a low joint can always be brought back to surface, if not by raising the joint ties, then by lowering the ties in the body of the rail.

The advantage in combining the two principles will be found especially important in laying track. The rail can be laid with the angle bar, and subsequently the sub-plates can be put in. At the same time, the angle bar is too short to interfere much with the expansion and contraction, yet the distance apart that the rails can run is limited. The base plate would last practically forever (possibly requiring straightening if it became bent), so that due allowance for this fact should be made when comparing the first cost with that of angle bars alone, which, of course, do not last a great length of time; in fact, deteriorate rather rapidly.

One improvement in Mr. Delano's joint, which suggests itself on examination of the drawings, is that of adding a stiffening rib on the under side of the bridge plate, so as to prevent any possibility of its being bent under heavy traffic. Mr. Delano is probably right that the angle-bar joint will continue to be the standard pattern for roads with comparatively light track and light traffic, and, as already stated, there is a very wide diversity of opinion as to the best form of joints for roads with heavy track and heavy traffic.

TWENTY YEARS OF PROGRESS IN THE MANUFACTURE OF IRON AND STEEL IN THE UNITED STATES—1870-90.

A summary of the progress made in developing the iron and steel industries of the United States, for the 20 years 1870-1890, is published by the Department of the Interior. This summary is the work of Mr. James M. Swank, the General Manager of the American Iron and Steel Association, an organization that has for its purpose the recording of all matters pertaining to these industries. The record here presented is phenomenal, as the bare figures which follow will make plain:

Taking iron ore first, we can construct from this report the following comparative table of late productions in tons in the chief ore-producing countries:

	United States.	Great Britain.	Germany and Luxemburg.	Spain.
1870.....	3,031,891	.....	.....	.....
1880.....	7,120,962	.....	.....	.....
1889.....	14,518,041	14,546,105	.....	.....
1890.....	16,036,043	13,780,767	11,406,132	5,788,743
1891.....	14,591,178	12,777,689	.....	.....

France, in 1887, produced only 2,579,465 tons. Of all iron-making countries Great Britain is the largest importer of iron ore, as is shown below, in comparison with other countries:

	Great Britain, tons.	Germany and Luxemburg, tons.	France, tons.	United States, tons.
1887.....	3,765,788	1,036,217	1,154,405	1,194,301
1888.....	3,562,071	1,163,373	1,310,695	.....
1889.....	4,031,265	1,234,789	1,545,363	.....
1890.....	4,471,790	1,522,501	1,610,244	1,246,830
1891.....	3,180,543	1,408,025	1,437,527	.....

The imports into the United States for these five years have been less than for any of the other countries, and from 1879 to 1891, inclusive, the average per year is 719,500 tons. The years of largest importations were 1886 (1,039,433 tons), and 1887 and 1890 given in the above table. In no year prior to 1879 did the imports amount to 100,000 tons.

From the above tables it is evident that the United States is the greatest producer of iron ore in the world, and is, as a consequence, more independent of foreign sources of iron ore than any other leading iron-making country. To this it may be added that new iron ore fields in this country are being constantly discovered and developed, and the supply for the future promises to be practically inexhaustible. There is, however, a scarcity of Bessemer ores on the Atlantic coast, and the imports are chiefly to supply this want. The Pacific coast is wanting in all iron ores.

As showing this rapid development of new fields, the Marquette, Menominee, Gogebic and Vermillion districts may be mentioned. The first experimental shipment of ore from the Marquette district of this Lake Superior region was made in 1850; but in 1872 the total shipment of ore from this section, including shipments to local furnaces, aggregated only 900,901 tons. In 1890, the year of largest production, the shipments aggregated 9,012,379 tons, or ten times the total for 1892. In the 20 years, 1872-1891, the shipments aggregated 59,617,497 tons, while the total for all preceding years amounted to only 4,593,818 tons. The several ore fields in the Lake Superior region were opened in the years named below with the first ore shipment given; compared with their output in 1890, they show the following development:

	Opened.	First shipment, tons.	1890 shipment, tons.
Menominee.	1877	10,405	2,280,017
Vermillion.	1884	62,124	890,204
Gogebic.....	1884	1,022	2,845,171
Marquette.	1850	.....	2,907,927
Grand total in tons.....			9,012,379

This grand total is 56% of the total production of iron ore in the United States for that year. The next most productive ore district in the United States is also one of the oldest in its working. This is the Cornwall ore district of Pennsylvania, operated since 1740. From that year to the close of 1891 these mines have furnished 11,514,995 tons of ore, of which 7,600,221 tons were mined between 1872-1891, inclusive.

The production of pig iron in the United States and Great Britain in the years 1872-1891 is compared in the following table:

Years.	Great Britain, gross tons.	United States, gross tons.
1872.....	6,741,929	2,546,713
1873.....	6,566,451	2,560,963
1874.....	5,991,408	2,401,262
1875.....	6,365,462	2,023,733
1876.....	6,555,997	1,868,993
1877.....	6,608,964	2,066,594
1878.....	6,381,051	2,301,215
1879.....	5,995,337	2,741,858
1880.....	7,749,233	3,835,191
1881.....	8,144,449	4,144,254
1882.....	8,586,680	4,623,323
1883.....	8,529,300	4,595,510
1884.....	7,801,727	4,097,868
1885.....	7,415,409	4,044,526
1886.....	7,009,754	5,683,329
1887.....	7,599,518	6,417,148
1888.....	7,998,969	6,480,738
1889.....	8,322,824	7,603,642
1890.....	7,904,214	9,202,703
1891.....	7,406,064	8,279,870
1892.....	.....	9,157,000

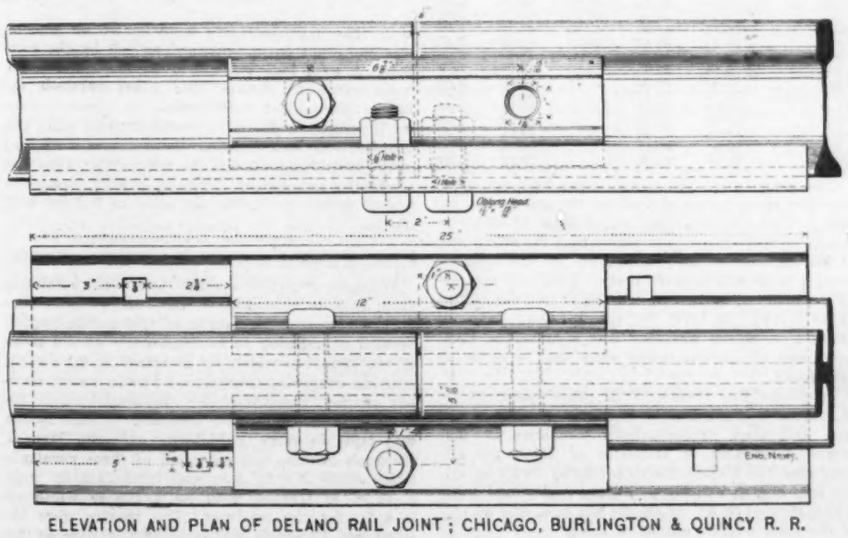
This table shows that while 20 years ago the pig-iron output of the United States was only a little more than one-third of that of Great Britain, it has in this period steadily and rapidly grown, until this country is now the largest producer of pig iron in the world. Previous to 1887 the statistics of the production of Bessemer pig iron were not preserved, but in that year the production was 3,220,517 net tons, and the total production was 7,187,206 tons. In 1890 the production was 4,583,424 tons, and the total production was 10,307,028 tons. The production of spiegeleisen and ferromanganese has grown from 4,561 tons in 1872 to 143,098 tons in 1891.

The manufacture of steel of all kinds has also made wonderful strides in the United States in these 20 years. In 1860 we made 11,838 gross tons of steel; and after falling off slightly in 1863-64, the industry steadily advanced until it reached a maximum of 4,277,071 tons in 1890. The output for 1891 was but little less, being 3,904,240 tons. Bessemer steel first appears in these totals in 1867, with 2,679 tons of ingots; and open-hearth steel first appears in 1869, with 893 tons of ingots. In the period 1872-1891 the output of Bessemer steel advanced from 120,108 tons to 3,637,107 tons in 1891; the make of open-hearth steel advanced from 3,000 tons in 1872 to 649,323 tons in 1891, and the totals of all kinds of steel increased from 160,108 tons in 1872 to 4,372,749 net tons in 1891. Until 1883 Great Britain was the leading steel-making country of the world; but in that year the United States took the lead with 2,562,503 gross tons, as compared with 2,344,670 gross tons for England. In 1880-1889 we lost this lead, only to gain it again in 1890 and 1891. The following table is very interesting as comparing, in gross tons, the manufacture of Bessemer steel ingots and steel rails in Great Britain and the United States:

Year.	United States, gross tons, ingots.	United States, gross tons, rails.	Great Britain, gross tons, ingots.	Great Britain, gross tons, rails.
1877.....	500,504	385,865	750,000	508,400
1878.....	653,773	491,427	807,527	622,200
1879.....	829,430	610,682	834,511	520,231
1880.....	1,074,262	852,196	1,044,382	732,910
1881.....	1,374,247	1,187,770	1,441,719	1,023,740
1882.....	1,514,687	1,284,067	1,473,649	1,235,785
1883.....	1,477,345	1,148,709	1,553,380	1,097,174
1884.....	1,375,531	996,983	1,200,676	784,968
1885.....	1,519,430	959,471	1,304,127	706,583
1886.....	2,269,190	1,574,703	1,570,520	730,343
1887.....	2,936,033	2,101,904	2,089,403	1,021,847
1888.....	2,511,161	1,386,277	2,032,794	979,083
1889.....	2,930,204	1,510,057	2,143,791	943,048
1890.....	3,688,871	1,867,837	2,014,843	1,019,606
1891.....	3,247,417	1,293,053	1,642,005	662,676

It will be seen from the above that the United States passed Great Britain in the production of Bessemer steel ingots in 1880, and since 1884 has steadily retained the lead. The United States has made more steel rails than England since 1879. Great Britain is, however, still far ahead in the make of open-hearth steel, the comparative outputs for 1891 being 1,514,538 gross tons, as compared with 579,753 gross tons for the United States. It is of interest in this connection to state that in 1872 the United States reached the maximum output of iron rails with 905,930 tons; in 1891 only 9,229 tons of iron rails were made.

This phenomenal growth in the steel rail industry is explained by the equally phenomenal growth of railways in the United States within the period named. In 1890 alone 110,358 tons of street rails were made for the 9,662 miles of street railways then in the United States. The mileage of steam railway track has increased from 115,647 miles, in



ELEVATION AND PLAN OF DELANO RAIL JOINT; CHICAGO, BURLINGTON & QUINCY R. R.

1880, to 214,687 miles in 1891, and the percentage of steel to iron rails used for this purpose has increased from 29.1% in 1880 to 81.5% in 1891. In the latter year there were still 39,756 miles of iron rails in use. The weight of rails in these 20 years has grown from 56 lbs. per yd. to 100 lbs. The average weight of all rails of 50 lbs. and upwards made by the Illinois Steel Co. in 1892 (to Oct. 1) was 68.1 lbs. per yd. As a historical fact worth preserving, it may be mentioned that the Pennsylvania R. R. Co., as long ago as 1858, ordered and laid down on its mountain division a large quantity of rails weighing 83 lbs. per yd. The experiment was not then regarded as sufficiently successful to warrant a continuation of the use of this heavy rail.

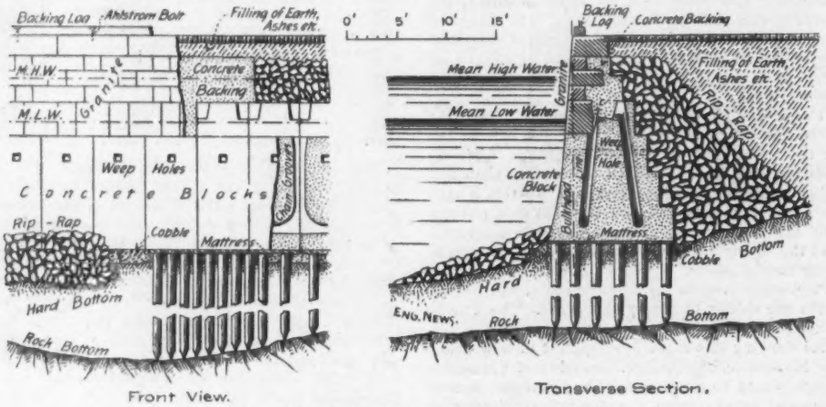


FIG. 1. BULKHEAD CONSTRUCTION, NEW YORK.

The nail industry also shows phenomenal growth in these 20 years. Taking first the iron and steel cut nails and excluding wire nails, we have the following exhibited in kegs of 100 lbs: In 1872 the output was 4,065,322 kegs. This output rose gradually to 5,011,021 kegs in 1879; to 6,147,097 kegs in 1882, and 7,762,737 kegs in 1883. The highest point was reached for this class of nails in 1886, with 8,160,973 kegs, and after that the product regularly fell to 5,002,176 kegs, in 1891, under competition with wire nails. Until 1888 all cut nails were made of iron, but in that year nails of Bessemer steel and combined iron and steel came into the market. In 1891 about three-fourths of the total product of cut nails were made of steel.

The first wire nails made in this country were manufactured in 1851-2, in New York, by William Hassell. They were small in size, made of iron and brass wire and chiefly used by upholsterers. The wire nail, as a substitute for cut nails, came into notice in 1883-84, and the American Wire Nail Co., of Anderson, Ind., was the first company to put this class of nails on the market. This company really dated from 1871, when a few German residents of Covington, Ky., imported three German wire-nail machines. In 1886 the manufacture of wire nails amounted to about 600,000 kegs of 100 lbs. each, made by 27 wire nail works. In 1887 the product reached 1,250,000 kegs; in 1888, 1,500,000 kegs; in 1890, 3,135,911 kegs, and in 1891, 4,114,385 kegs; nearly all these wire nails being made of steel. We understand that a new wire nail machine is being brought out which makes 20 or more nails, where the older machines made one, and is practically noiseless in operation. The promoters claim that in the near future steel wire nails will cost very little more than the metal of which they are made.

During the last 20 years iron and steel have entered more and more into buildings of all kinds and into bridges, and while the statistics are lacking for the quantity so used, it is a constantly and rapidly increasing figure.

In iron and steel shipbuilding, excluding warships, the increase since 1872 has not been so rapid as we would wish; but where we built only 20 vessels of an aggregate tonnage of 12,766 tons, in 1872, in 1891, we built 76 vessels of 105,618 total tonnage. In the interval 1872-92 we built 695 iron and steel vessels, of which 679 were steam vessels. For our new navy we have now built, or have under contract, since 1883, 40 vessels of an aggregate tonnage of 155,820 tons, and have expended upon these ships nearly $70,000,000.

With the increase in production of iron and steel in the United States since 1872, the average annual price has steadily fallen, as is shown in the following table for five leading iron and steel products, compiled from the records of the American Iron and Steel Association. These prices are yearly averages of monthly quotations per gross ton at Pennsylvania mills for all except cut nails, which are wholesale at Philadelphia:

Year.	No 1, anthracite foundry pig iron.	Best refined bar iron.	Iron rails.	Steel rails.	Cut nails per keg.
1872. . . .	$48.88	$97.63	$85.13	$112.00	$5.46
1873.	42.75	86.43	76.67	120.50	4.90
1874.	30.75	67.95	58.75	94.25	3.99
1875.	25.50	60.85	47.75	68.75	3.42
1876.	22.25	52.08	41.25	50.25	2.98
1877.	18.88	45.55	35.25	45.50	2.57
1878.	17.63	44.24	33.75	42.25	2.31
1879.	21.50	51.85	41.25	48.25	2.69
1880.	28.50	60.38	49.25	67.50	3.68
1881.	25.12	58.05	47.13	61.13	3.09
1882.	23.75	61.41	45.50	48.50	3.47
1883.	22.38	50.30	.....	37.75	3.06
1884.	19.88	44.65	.....	30.75	2.39
1885.	18.00	40.32	.....	28.50	2.33
1886.	18.71	43.12	.....	34.50	2.27
1887.	20.92	49.37	.....	37.08	2.30
1888.	18.88	44.99	.....	29.83	2.03
1889.	17.75	43.40	.....	29.25	2.00
1890.	18.40	45.92	.....	31.75	2.00
1891.	17.52	42.56	.....	29.92	1.86

The compiler of the above table does not note whether these prices are all on the gold basis or not; but as they are given as averages of monthly market quotations, it is probable that the prices are in the currency of the years given. In this connection, it is as well to state that in 1872 gold was at 12% premium; in 1873 it was 13%; in 1874, 12%; in 1875, 14%; in 1876, 10%; in 1877, 5%, and in 1878, 2%. Specie payment was resumed in that year, and all market prices after that were on a gold basis.

In closing this review of 20 years' progress, it is evident that the United States is the first of all iron and steel manufacturing countries in the world. According to statistics of 1890, for all countries, the United States produced 28.1% of all the iron ore, and 27.8% of all the coal mined, and manufactured 33.9% of all the pig iron, and 34.7% of the total world's output of steel.

NEW YORK BULKHEAD CONSTRUCTION.

From the last report of Mr. George S. Greene, Jr., Engineer in Chief of the New York Dock Department, are taken the drawings here given showing the new plan adopted for constructing bulkhead walls along the river fronts.

The plan followed was that shown in the cuts. Generally described, the site was dredged to a depth of 16 ft. below mean low tide, and for a width of about 19 ft., and on a slope of from 16 to 20 ft. below mean low tide for about 20 ft. from the front of the toe of the base block. The soft mud was dredged down in the rear of the wall as far as the rip-rap embankment extends. The piles were then driven in transverse rows of six, 3 ft. apart longitudinally on centers, except in the front row, where the piles were 1½ ft. apart, c. to c. Transversely the piles were spaced as follows, commencing with the front row: 2 ft. 3 ins., 2 ft. 6 ins., then 2 ft. 9 ins., to the end. The piles were cut off by a circular saw at 14.77 ft. below mean low tide, and no pile was less than 12 ins. in diameter at the point cut off. Wire screens made of heavy wire netting were used to locate the piles after being cut off.

Mattresses of mortar were used on the tops of the piles to furnish an even bearing, after a manner used in this department since 1876. But before the mattresses were put in place the loose or soft mud between the piles and for 20 ft. in front of them was pumped or washed away to hard material, and the space between the pile-heads was filled with cobble to the tops of the piles, and rip-rap was filled in in front as shown.

The concrete baseblocks, Fig. 2, were of the dimensions there given; the material and method of construction followed the usual department practice. The upper surfaces were floated off smooth, and the other parts remained as left by the rammer. A weep hole was cut in the block and chain-holes made as shown. The joints between the blocks were filled with oakum to prevent wash on the under side of the concrete backing. The granite walls surmounting these blocks were laid in the usual manner, and the concrete backing was made of quick-setting Portland cement, sand and broken stone, practically the same as for the base blocks.

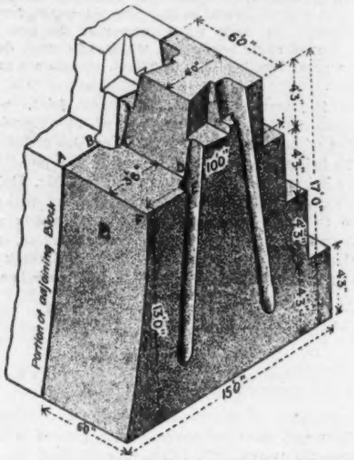


Fig. 2. Concrete Block Used in Bulkhead Construction, New York.

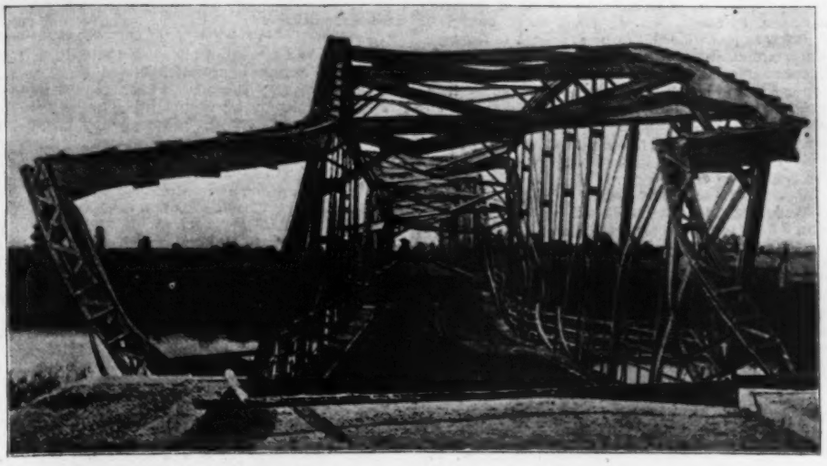
FAILURE OF A HIGHWAY BRIDGE, SERVIA.

We have recorded a great many bridge failures from time to time, but of them all we remember only one or two the details of whose construction seemed so palpably to invite disaster as did those of the structure which we illustrate in the accompanying engraving, reproduced from a recent number of the "Zeitschrift des Oesterreichischen Ingenieur und Architekten-Vereines." This bridge was built to carry a highway over the Morava River, in Servia, and consisted of three parabolic truss spans 201 ft. long each and 21.2 ft. wide c. to c. of trusses, with an available width of 16.4 ft. for the roadway. The trusses were divided into 12 panels, and were 28.8 ft. high at the center, and 11.5 ft. high at the ends. No dimensions of the various members are given, but their forms can be seen quite clearly from the illustration. The chords are made up of webs and angles, connected at intervals by small angle ties. The verticals consist of two U-irons connected at intervals by horizontal plates, and the diagonals are flat bars.

The proposals for the construction of the bridge were prepared by the Servian government, and required a design providing for a railway in addition to the highway. Three designs were submitted and received the stipulated awards, but a new design, after which the bridge was built, was prepared under the direction of the government officials. The piers and abutments were built under the supervision of the Servian Department of Works, but the contract for the superstructure was awarded to a Belgian firm. The strains are

stated to have been calculated for a uniform load of 82 lbs. per sq. ft. Tests of the metal used showed good results.

The bridge failed under the test load of gravel which was distributed over the flooring. The full load to be used was 155 tons, under which a deflection of 1 1-16 ins. was expected. Only about 131 tons of this load had been applied, however, when the whole span collapsed and settled on the false work, which had not been removed. This load was in the form of about 10.6 ins. of gravel distributed over seven panels, and 8 ins. over the remaining five panels. This would be for the first seven panels a load of about 114 lbs. per sq. ft., calling the weight of gravel 130 lbs. per cu. ft., and for the remaining five panels about 79 lbs. per sq. ft.



FAILURE OF A HIGHWAY BRIDGE, SERVIA.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Power of City with Respect to Water Company's Franchise.

A village being responsible for injuries caused by defects in its streets, and being charged by law with the duty of keeping them in repair, may maintain an action to prevent them being torn up or excavated. Where a village grants to a corporation the right to lay pipes in its streets, and the by-laws of the village provide for a reconsideration of any question at the same or next meeting, and a motion is adopted to reconsider the ordinance granting the right of way at the next succeeding meeting, and before the ordinance took effect, and before the company accepted the grant or made expenditures, the grant is revoked, and the village may enjoin the laying of the pipes. (Waukesha Hygeia Mineral Spring Co. v. Village of Waukesha, Supr. Ct. of Wis., 53 N. W. R. 675.)

Damage for Negligent Excavation of Street.

Where a city excavated a street so negligently as to take away the support of an abutting lot, causing the soil of such lot to slide into the street excavated, the injury is not merely consequential, but is direct, and the owner can recover damages from the city therefor, independent of any provision that no private property shall be taken or damaged for public use without just compensation. The owner is also entitled to recover for injuries to buildings caused by the removal of support to the soil on which they are situated, when the weight of the buildings did not contribute to the sliding of the soil and to the consequent injuries to the buildings. (Parke v. City of Seattle, Supr. Ct. of Wash., 31 Pac. Rep., 310.)

When Damages to Property Exceed Benefits.

The permanent grade of a street must be established before the street can be permanently graded at the expense of the real property. The board of public works, in apportioning the benefits to the respective lots for grading a street, without regard to their situation in other respects or how they might be affected by the grade, adopted and acted on an arbitrary rule, taking into account only the proximity of the lots to the street. Held: that the assessment was void. (Shannon v. Judges of Dist. Ct. of Minn., 11th Dist. Supr. Ct. of Minn., 53 N. W. Rep. 800.)

The North Sea-Baltic Canal, fully described in Engineering News of March 26, 1892, has entailed an expenditure of $29,000,000, and the estimated cost of finishing it is $10,000,000 more. So far 52,000,000 cu. m. of earth, clay and rock have been removed. On Oct. 1, 1892, 5,868 men were engaged on the work. It is expected that the canal will be opened to traffic in 1895. Instead of the three single locks at the Elbe, and a single lock at the Kiel port, originally intended, double locks will be used everywhere, each 500 ft. long and 82 ft. wide.

PERSONAL.

Mr. J. P. Andrews, Superintendent of the Bureau of Highways, Pittsburg, Pa., died Jan. 26.

Mr. G. M. Eldridge has been re-appointed City Engineer and Superintendent of Water-Works of Americus, Ga.

Capt. S. G. Fassett, of Beadle Co., S. Dak., has been appointed State Engineer of Irrigation for South Dakota.

Mr. James W. Wilson has been re-elected a member of the North Carolina Railroad Commission for a term of six years.

Mr. Orville Augustus Roorbach, Secretary and Treasurer of the Northern R. R. of New Jersey, died in New York, Jan. 26.

W. E. Caldwell has resigned his position as Associate Editor of the "Electrical World," and has gone to Chicago as editor of the "Street Railway Gazette."

Mr. Matthew Kays, who was for 30 years Superintendent of the New York Cement Works, Rosendale, N. Y., died in New York, Jan. 23, at the age of 82.

Mr. J. G. Cutler has been appointed Chief Engineer of the Washington & Columbia River Ry., with headquarters at Walla Walla, Wash., vice Mr. C. E. Sears, resigned.

Mr. N. D. Miller, Chief Engineer of the Great Northern Ry., has also been appointed Chief Engineer of the Montana Central Ry., vice Mr. E. H. Beckler, resigned.

Mr. Dion Geraldine, formerly Superintendent of Construction of the World's Columbian Exposition, has been appointed City Engineer of Chicago, vice Mr. L. H. Clarke, resigned.

Mr. Bernhard Feind, of Chicago, has been engaged as Consulting Engineer to that city, at a salary of $3,000 per year. Mr. Feind has also been engaged to prepare plans for a system of water-works for Evanston, Ind.

Mr. H. A. Gillis has resigned his position as Division Master Mechanic of the New York, Lake Erie & Western R. R., at Port Jervis, to accept that of Superintendent of the Roanoke Locomotive & Machine Works, Roanoke, Va.

Mr. W. S. Shields has opened an office in the Title & Trust Building, Chicago, for the practice of civil and municipal engineering. He has been connected with Mr. John A. Cole, consulting engineer, of that city, for the past nine years.

Mr. George S. Webster has been appointed Chief of the Bureau of Surveys, Philadelphia, Pa., vice Mr. Samuel L. Smedley, resigned. He has been Acting Chief for nearly a year, and has been connected with the Bureau of Surveys for 16 years.

Mr. Charles Hansel, Consulting Engineer to the Railroad & Warehouse Commission, of Illinois, has been appointed Chief Engineer of the Signal Department of the Wuerpel Switch & Signal Co., of St. Louis, Mo. His report on his examination of English railways last year will be published in the next annual report of the commission.

Mr. L. W. Finley, who died Jan. 18, was one of the oldest highway bridge builders of this country. He was born in 1833 at Castle Fin, Pa. At the age of 12 he was helping his father, John Finley, build wooden bridges, and at 20 he was taken into partnership with his father. He was among the first builders of iron highway bridges, and was for about 22 years associated with the Wrought Iron Bridge Co., of Canton, O.

Mr. John F. Haskins, M. Am. Soc. M. E., M. Inst. M. E., and Mr. John J. L. Houston, Assoc. M. Am. Soc. C. E., have formed a partnership under the firm name of John F. Haskins & Co., with office at the Monadnock Building, Chicago, to carry on a general practice in general engineering. Mr. Haskins has, until recently, had offices in Philadelphia and London, but will hereafter be permanently located at the above address. Mr. Houston was for several years connected with the Pennsylvania R. R.

Mr. John Inshaw, who died recently at Aston, England, was born in 1807, and early devoted himself to engineering, and the Stephensons on many occasions consulted him, especially concerning locomotive wheels. Mr. Inshaw is said to have invented twin-screw propellers, and in a steamer competition, which took place on the Regent's Canal, in London, won the prize of $500 for accomplishing the distance in the shortest time. An injector for filling boilers was also invented by Mr. Inshaw. He provided steam coaches to run between Birmingham and London, but these were not financially successful, as railways had by that time been made. It is said that when he was only 14 years old he lit his father's house with gas, and for a long time made the gas himself.

NEW PUBLICATIONS.

REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF NORTH CAROLINA, for the year ending Dec. 31, 1892. Pub. Doc.; 8vo. cloth; pp. IX. + 661; map.

All but the first nine pages of the report is taken up with the reports of the separate railway companies, and a copy of the laws establishing the commission. There are now 3,593 miles of railway in the state, 114 miles of which were put in operation in 1892. The total assessed value of this railway for taxation is $19,726,760. There is nothing of technical interest in the report.

REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF MAINE, for the year ending June 30, 1892. Pub. Doc.; 8vo. cloth; pp.136 + 182 in appendixes; illustrations and map.

A very large proportion of the report proper is taken up with the discussion of automatic couplers and the necessity of regulating the construction of electric and street railways to prevent crossings of steam railways at grade. In the discussion of automatic couplers we are glad to note that the Commissioners show a more progressive spirit than has characterized their previous reports. The stand taken upon the question of both street railway and highway crossings at grade is also to be recommended. Aside from these there is very little of technical interest.

A GRAPHICAL METHOD FOR SWING-BRIDGES. A Rational and Easy Graphical Analysis of the Stresses in Ordinary Swing-Bridges, with an Introduction on the General Theory of Graphical Statics. By Benjamin F. La Rue, C. E., New York, 1892; D. Van Nostrand Co.; 16 mo. boards; pp. 104; folding plates; Van Nostrand's Science Series, No. 107; 50 cts.

The meat of this little book is contained in the brief explanation of the simple and apparently theoretically correct graphical method devised by the author for computing the strains in swing bridges. The bridge, however, is treated as a continuous girder of only two spans, it being considered that the negative reactions at the ends possible under certain conditions of the loading is provided against by latching them down, which assumption, of course, much simplifies the computation of the strains.

THE PRECISION OF MEASUREMENTS. Discussion of. With examples taken mainly from Physics and Electrical Engineering. By Silas W. Holman, S. B., Associate Professor of Physics, Massachusetts Institute of Technology. New York, John Wiley & Sons. 8vo, pp. 176; $2.

Starting with the valid statement that the grade of accuracy of a measurement must be adapted to the purpose for which the result is desired, the author points out the necessity for extreme precision in many measurements demanded by the advance of modern science, such as the efficiency and duty of an engine, the efficiency of a dynamo or power-station, measurements of an index of refraction, the comparison of standards of length, etc. The engineer, physicist and chemist are all deeply interested in the refinement of measurements, and upon the degree of this refinement the value of their deductions will generally rest. The engineer is here told that in so simple a measurement as that of the distance between two points by means of a steel tape, there are no less than nine possible sources of error to be dealt with. It is impossible to go into detail of treatment, and we can only here say that the author discusses the subject most fully; gives examples and works them out, under the various heads of his topic. It is a seasonable work, and by the very

nature of its contents shows the demand for extreme precision brought about by the introduction of new methods and devices now practically in common use, especially in electrical work.

CAB AND CABOOSE. By Kirk Munroe. Rail and Water Series of Books for Boys. Illustrated. G. P. Putnam's Sons. $1.25.

This is a story of a railway boy who commences by winning a bicycle race for the "railroad cup," is at first a brakeman and then a fireman on a locomotive; finally becomes private secretary to the president of the road by reason of his merit and quick wit in several emergencies, and is left in the last chapter, as a prominent candidate for the hand of the president's daughter, thus ending as all the heroes of good novels should. In his brief career Rodman Blake encounters tramps and train-robbers, figures in thrilling wrecks and makes some wonderful records for speed. There are a villain, a railway dog, and the other usual accessories to a tale of this kind. But, taken all together, it is a well-told tale and a healthy one, and will be appreciated by the boys for whom it is written.

TRADE PUBLICATIONS.

CHAIN BELTING, ELEVATING AND CONVEYING MACHINERY. Catalogue of the Jeffrey Mfg. Co., Columbus, O. 12mo, pp. 256.

This is a handsome catalogue and price list fully describing and illustrating the special features manufactured by this firm. To those not intimately acquainted with the trade, the number of purposes for which conveyors alone are now used is a revelation, as here set forth. The name is usually associated with the handling of grain; but we here see that coal, coke, broken stone, ores of all kinds, bales, packages and beer kegs, tanbark, straw and paper pulp, clay, phosphates, lumber, etc., etc., are carried by various forms of this same useful contrivance. The chains, buckets, aprons and other appliances differ so widely in their adaptation to special use that the interested reader must be referred to the excellent illustrations here given, accompanied by dimensions and prices.

SOCIETY PROCEEDINGS.

MICHIGAN SOCIETY OF ENGINEERS.—The fourteenth annual convention was held at Lansing, Mich., on Jan. 17, 18 and 19. President E. W. Muenscher in the chair. The president in his address confined his remarks mainly to the difficulty in getting desirable papers to be read and discussed at these meetings. He prescribed a remedy by enumerating subjects of interest, including the following: How a camp and operations in the forests would be laid out; the question of the transportation of lumber, etc., the sinking of brine wells, city engineers to account for the last year's work, etc., and how the difficulties in connection with these and other enterprises are overcome. A permanent committee to co-operate with the secretary in this matter was appointed. Secretary Hodgman reported that no invitation had been extended to the Society to take part in World's Columbian Exposition Congress. A. L. Reed then read a paper on "Southern California and One of Its Water Systems;" J. Randall described an egg-shaped water supply reservoir built at Mio, Mich., 30 ft. in diameter, 16 ft. high, lined with cement 1½ ins. thick, backed directly against sand. No gravel was used in the construction. The peculiar feature was the building of the wall from the surface downward. The sand was shaved off carefully to a smooth and compact surface, and a 1½-in. layer of cement placed on this surface. It has stood for four years without leaking. Cost, $3,000. "Specifications," John Harris; "Autobiography of J. C. Foster"; "Establishment of Monuments in Surveying," F. L. Church; "Cemetery Plots," D. J. Albertson; the report of Committee on State Boundary, George M. Steele, was accepted, and a memorial to the Legislature ordered prepared providing for a new and accurate survey, to be made jointly with the surveyors of adjoining states. The second day was set apart for the discussion of road laws and road making. A paper was read by President Muenscher, in which he stated that through the efforts of the press, state committees, etc., interest in roads was never so great as at the present, and while it would be difficult to exaggerate the condition of roads in many parts of the state, much of the criticism was unjust because of the newness of the state, and the many natural obstacles that had to be overcome in settling it before the question of roads was considered at all. Education as to the pecuniary and social benefits he said was the first essential, legislative action the second. A general discussion on the subject of taxation, state management of roads, how to build and maintain them, etc., followed. A letter was read from T. S. Bailey, on "Roads from the Grangers' Point of View"; "Road Laws," Prof. R. C. Carpenter; "Road Laws in New York," O. C. Gillette; "In Iowa," Seth Dean; "In New Hampshire," Mr. Giles; "In Florida," S. C. Hodgman. The opinion generally expressed in these letters was that the laws are fragmentary, and show that little or no consideration has been given to them. "Legislature for Better Roads," Geo. M. Steele; "Roads and Road Making in Oklahoma," J. J. Watkins. Mayor Bement in his address of welcome stated that the reason there were so many poor roads is because of the failure to properly recognize the value of the engineer in the industrial world. The same sentiment was expressed by Mr. Garfield, who spoke from the grangers' standpoint. "Relation Between Railways and Highways," E. French. J. T. Hubbell recommended that to secure the assistance of railways, contracts be made with them for their construction, work to be in charge of the engineering department of such roads. "Location and Relocation," Geo. M. Steele"; the State Roads Commission's report was discussed. "Road Building," H. C. Thompson; "Road Making," T. S. Bailey. The discussion on the road question led to the appointment of Secretary Hodgman, D. Skells, Wm. Appleton, M. H. Bailey, H. F. Bean, to prepare a bill to be presented to the legislature, recommending the advisability of a constitutional amendment so that the county instead of the township might have charge of the construction of highways. If a constitutional amendment could not be obtained to ask the legislature for the passage of laws giving the township the right to prescribe the kind of roads to be built and to assume their construction. The report was adopted.

"History of the Water Supply of Grand Rapids," G. M. Ames; "Staking Out Plots," A. J. Teed; "Relation of Railways to Roads," H. E. Riggs. This was a strong plea for the abolition of grade crossings, containing statistics of accidents at grade crossings, etc. Officers were nominated for the following year as follows: President, E. W. Muenscher; Vice-President, Geo. S. Pierson; Secretary and Treasurer, F. Hodgman. On the last day of the meeting the following papers were read: "Highway Bridges," B. F. La Rue; "Grand Haven Water-Works," Geo. S. Pierson; "Swing of Compass Card," H. C. Pierson; "Grading of Streets," A. Marhoff.

The following exhibits were made: Lufkin's rules and new steel tape (Eng. News, Dec. 15, 1892); Parkhurst patent artificial combined curb and gutter, by John J. Granville, Saginaw, Mich.

NORTHWEST RAILROAD CLUB.—The club held its annual meeting for the election of officers at St. Paul, Jan. 10, and the election resulted as follows: President, William McIntosh; First Vice-President, John Hickey; Second Vice-President, E. A. Williams; Secretary, W. D. Crosman; Treasurer, H. L. Preston.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Jan. 18, President Moore in the chair, and 26 members and 3 visitors present, Mr. Geo. H. Pegram presented a paper on "The Bridge Across the Arkansas River at Fort Smith." The piers were built of concrete, using Portland cement, and the method of erection was shown and illustrated with drawings. The specifications were read and the tests of materials used were presented in tables. The ironwork was described and full drawings showed the design and calculations.

Arthur Thacher, Secy.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting Jan. 10, Dr. John W. Langley, of the Case School of Applied Science, read a paper on, "Some Physical Properties of Steel as Related by Its Structure and Composition." Steel, he said, is defined as a solution of several elements in iron; the principal elements being carbon, silicon, phosphorus and manganese. Limitations of the scope of the definition to "high steel" were given and an explanation of the terms combination and solution, with reasons for considering steel to represent the latter rather than the former. The influence of the above four elements on the fusibility, hardness, toughness, and the disposition to crack were given by a set of curves, showing the relation between the property in question and the quantity of the added elements. The subject of the hardening and annealing of steel was then discussed, and the phenomenon of recalescence illustrated by graphical construction.

Chas. S. Howe, Secy.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the regular meeting in Pittsburg on Dec. 20, an amendment to the by-laws was made, creating an initiation fee of $5 and increasing the annual dues to $7 for resident members (those living in Allegheny Co.), the dues of non-resident members remaining at $5. Mr. W. C. Coffin, Jr., read a paper on "The Construction of Iron and Steel Tanks," giving a summary of modern practice in construction of tanks, with some suggestions in detail.

Three joint meetings of the American Chemical Society and the Chemical Section of the Engineers' Society of Western Pennsylvania, were held Dec. 28 and 29, 1892, at Pittsburg, and the following papers were presented: "The Effect of Decomposing Organic Matter on the Solubility of Natural Phosphates," Prof. N. B. Lupton, Alabama; "Official Milk Analysis," Prof. W. H. Ellis, Toronto, Can.; "Plant Lice Honey," Dr. H. W. Wiley, Washington; "Composition of Modern Powders," Prof. C. E. Monroe, Newport; "Lithographic Limestones," Prof. C. W. Volney, New York.

Prof. G. C. Caldwell delivered a retiring address on "The Work of the American Chemist." Plans for the Congress of Chemists at the World's Columbian Exposition were discussed, and excursions were made to various metallurgical works and factories.

MONTANA SOCIETY OF CIVIL ENGINEERS.—At the fifth annual meeting, held at Helena, Mont., Jan. 14, there was a discussion on the bill introduced in the legislature to establish irrigation departments and to create a state irrigation commission. The following resolution was unanimously adopted:

Resolved, That this Society favors the control of the waters of the state for irrigation purposes and the construction of irrigation works by the state, provided that suitable safeguards are made for the rights of individuals and the proper disbursement of moneys. We do not, however, consider the provisions of the bill now before the legislature adequate for the purpose for which it is designed. We would also recommend that the engineering work should be under the direction of a state engineer appointed by the governor of the state.

A paper on a method of plumbing a mining shaft was read by A. Neustaedter, of Helena, and Mr. G. O. Foss exhibited a profile showing the grades of the transcontinental railway lines. The following papers were also read: "Wooden Piping of the Butte Water System," by Fred P. Gutelius, who was the engineer in charge of the reservoir pipe line: "Lining of the Wickes Tunnel," by E. R. McNeil, assistant engineer in charge. The following officers were elected: President, W. A. Haven, of Helena; First Vice-President, J. S. Keerl, of Helena; Second Vice-President, Prof. A. M. Ryon, of Deer Lodge; Secretary, G. O. Foss, of Helena; Treasurer, A. S. Hovey, of Helena; Trustee for three years, F. McRae, of Helena.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—The tenth annual meeting was held Jan. 9, with thirteen members and three visitors present; President Woodman in the chair. Reports were presented, and the election of officers resulted as follows: President, Geo. L. Wilson; Vice-President, J. D. E. Stabrook; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. Munster; Representative on the Board of Managers of the Association of Engineering Societies, C. J. A. Morris. Mr. Joseph S. Sewall, M. Am. Soc. C. E., designer and engineer in charge of construction of the bridge over the Mississippi River, connecting Marshall Ave., in St. Paul, with Lake St., in Minneapolis informally presented some interesting particulars concerning that structure. The bridge consists of two principal iron arch spans of 456 ft. each, and its total length is 1,273 ft. A 20-ft. roadway is laid on 7 × 16-in. wooden stringers, and is designed to admit the passage of a 15-ton road roller. There is a 5-ft. sidewalk on each side. The appropriation was limited to $150,000, and was to cover all preliminaries. The cost of the substructure (abutments resting on sand rock and pier on gravel) was $32,360; superstructure, $109 10). Portland cement was used in freezing weather only. Work was begun in 1887 and finished in May, 1889, considerable delays being caused by the non-arrival of material.

Mr. W. H. Wood gave some particulars of a five years' sojourn in southern Mexico. In his remarks he touched upon the novel methods of promoting and carrying on engineering enterprises in the far South, as exemplified by the construction of the Mexican Southern Railway and the drainage of the city of Mexico. About 20% is estimated as the cost of engineering on railway work.

C. L. Annan, Secy.

ENGINEERS' CLUB OF MINNEAPOLIS.—The annual meeting was held Jan. 12, President W. A. Pike in the chair. The following officers were elected for 1893: President, F. W. Cappelen; Vice-President, John M. Hazen; Secretary and Treasurer, Elbert Nexsen; Librarian, A. B. Coe; Board of Managers of Association of Engineering Societies, W. A. Pike.

Mr. Charles Steiner, C. E., of Zurich, Switzerland, a guest at the meeting, read a paper on the utilization of Minnehaha Falls for power purposes. He had investigated the falls and made a preliminary estimate based upon a flow of about 150 cu. ft. per sec. as a minimum, with an effective fall of 93 ft., giving about 1,600 HP. The cost of the improvement he estimated at $35,000. He had submitted his proposition to the Park Board, but it was not favorably considered, as his scheme would spoil the park. Mr. Steiner, however, proposed to beautify the park in many respects, and let the falls run on exhibition, say a few hours, three times a week. The discussion brought out the fact that last year was an exceptionally wet one, and that in six or seven years so much water had not been seen go over the falls, but that for several years the entire amount of flow in Minnehaha Creek could be taken care of in a box 12 × 24 ins., and not more than half full. By storing the necessary water, however, in the surrounding lakes, and using it in dry seasons, Mr. Steiner proposed to overcome all troubles of that kind; but he had not considered the cost of establishing such reservoirs. He estimated also about 0.6 cu. ft. per sec. per sq. mile, which, according to Mr. Fanning, was about double of what he at best might expect. The estimated cost of his improvements were also considered too low.

F. W. Cappelen, Secy.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting Feb. 1, the first paper read was by Robert Cartwright, on the "Construction of the Power-House of the Rochester Power Co., Adjacent to Genesee Falls, Rochester, N. Y." The Genesee River drains an area of about 2,500 sq. miles, and at times pours a flood over the falls in the city of Rochester, with a volume 293 ft. wide, and 5 to 6 ft. deep; the perpendicular fall being 90 ft. By a series of dams the water is used four times before it reaches the level of Lake Ontario. The power-house is close to the falls, where the great scour made it impracticable to use a timber coffer-dam. This scour was increased by a wing-dam above the falls, which turned the water toward the side where the power-house was to be built. The rock at the site was undercut by the action of the water, and the first operation was to blast off the overhang to a batter of 1½ in 10. Operations were carried on day and night, from early in 1890 to November, 1891 (except in freezing weather), since which time the water-power has been in use.

The plant consists of two double Leffel wheels, 26½ ins. in diameter, each supplied by a 5-ft. flume under an effective head of 87 ft., with a volume of 6,250 cu. ft. of water per min., and a development of 600 HP. by each. The wheels are of phosphor bronze with tinned Otis steel buckets. The power is transmitted from a 5-ft. rope-wheel to a 12-ft. rope-wheel 90 ft. above, through 16 manilla ropes, 1⅜ ins. diameter. The ropes are adjusted by a tightener wheel in an adjustable frame. Each wheel has its own flume and gate, and can be used independently. The ropes run at the high speed of 7,540 ft. per min., and no delay has occurred in over a year's use. The rock at the top of the falls, which is an easily disintegrated shale, overhangs some 20 ft., and the pool below is 40 to 50 ft. deep. The depth at the northwest corner was 10.7 ft., and 13 ft. to the northward, 22 ft. deep, giving a slope of 45°. The river sometimes rises to half flood in 24 hours, and sometimes when no rain has fallen at Rochester.

A timber coffer-dam in such a location was not to be thought of; and after careful consideration it was decided to use the rock blasted from the overhang above to fill up the pool below. A mass of stone blocks was thus raised 12 to 15 ft. above water and extending outside the foundation. Pumps with 4 and 6-in. suction pipes were used to lower the water. At the point where the solid rock was highest the debris was then removed, level benches cut, a heavy footing course laid in Portland cement mortar, and the masonry carried above high water. More broken rock was then removed for about 8 ft. further out, and the irregular spaces filled with dry cement mortar in bags trodden into place. The benching was then done, and the same process followed. By this method, which exposed only a small surface at any one time, all the footings were finally put in and the wall carried above water level. The cost was less than that of a coffer-dam, even supposing the latter practicable. Stones of 1 to 2 cu. yds. were carried away by the current.

The second paper was by James Duane, on "The Effect of Tuberculation on the Delivery of a 48-in. Water Main." In 1880-81 the writer laid a 48-in. main in 10th Ave. and 85th St., New York, for the purpose of diverting a part of the flow of the aqueduct into the old receiving reservoir in Central Park. This line started from 93d St., and ended at the gate-house in 85th St. near 8th Ave. In 1871-74, the old aqueduct in 10th Ave., between 93d and 113th Sts., was replaced by six lines of 48-in. pipe. These mains were all laid true to grade and with curves of 50-ft. radius. At the junctions with the masonry they had converging mouth-pieces. They were, however, for some reason, laid without the coal-tar coating, now universally applied. The writer, in making the connection of the line laid in 1881, with one of the old mains at 93d St., found the latter to be tuberculated to a surprising extent. These tubercles were all of the same general shape—that of roughly-formed frustra of cones, with a diameter of base of two or three times their height. The largest, which were 2 to 3 ins. diameter and 1 in. high, were, as a rule, found near the bottom of the pipe, but the interior was nearly covered by them.

Bench marks were established on the cover of each manhole, and joined carefully by levels; so that direct measurements could be made to the surface of the water, and thus establish its level above datum. As the quantity of water discharged was at this time very uniform and was accurately known, the value of C in the formula $V = C\sqrt{R}$ could be quite closely determined. In the aqueduct a value of C = 135 gives satisfactory average results, and the flow at this time was 96,000,000 gallons per day. Part of this flow was withdrawn at points above, and a net flow of 92,500,000 gallons per day entered the 10th Ave. mains, making 18,500,000 gallons for each main. The observed loss of head in a length of 5,992 ft. was 3.39 ft., giving C the remarkably low value of 96, or about 30% less than that assigned to it in modern practice.

After connections were made between the most westerly of the old pipe and the new pipe laid in 1881, there was a continuous line of 48-in. pipe, of which 5,306 ft. were tuberculated and 4,123 ft. were clean. The observed loss of head in the first was 1.86 ft., and in the second, 0.74 ft.; in other words, the value of I in the first was .00035 against .00018 in the second, or about double. Taking C in the first at 96, gave 14,500,000 gallons per day discharge, and this in the new main using I, as determined by observation, gave C = 134.

Eleven years later the new main was free from tubercles, and observation showed its discharging capacity unimpaired. The conclusions are, that Croton water will cause bad tuberculation in an uncoated pipe in seven years. That after a certain time this deterioration does not seem to increase. That a loss of 30% in discharging capacity is occasioned by the absence of tar coating; or, in other words, that such a coating is worth about $20,000 per mile. Finally, that after eleven years' service, tar coating seems to have perfectly protected the new main from tuberculation.

LIVERPOOL ENGINEERING SOCIETY.—A paper on "Geological, Manufacturing and Other Notes on Iron" was read Jan. 11 by Thomas Morris, F. G. S. He gave an account of the formation of ironstone, and described the enormous changes that have been brought about by the disintegration of the old rocks through the agency of time and the physical forces of nature. A sample believed to be one of the earliest formed ironstones would cut glass, and the only apparent difference between the true granite and the specimen of iron ore was one of altered quantities.

Passing from the formation of ironstone, the author proceeded to the calcining and smelting of the ores and the preparation of castings. Engineers' specifications for cast iron were criticised, the lecturer advocating, as he did in a former paper on wrought iron, a uniform standard of tests. He thought that it should be discussed by a few well-chosen men who know the nature and properties of cast iron, and from their conclusions should emanate some uniform specifications of tests capable of being converted by so much per cent. less than, or more than, the strains arrived at, thus making it more easy or more difficult to comply with in proportion to the strength the engineer knows he should have in the work he is constructing. The properties of cast iron of greatest importance in construction and mechanical engineering are tenacity, transverse strength, power to resist impact, power to resist fatigue, and power to resist compressing or crushing forces. To these must be added, in the case of the founder and turner, fluidity, hardness and texture. He then described the puddling process, whereby the cast iron is converted into malleable or wrought iron. Mr. Morris thought it was not creditable to have to say that neither the medicines of the metallurgist nor the inventions of the engineer have assisted the ironmaster to produce iron cheaper, or lessen the labor of the puddler, except the introduction of Nasymth's steam hammer. The effect of careless workmanship in the puddling furnace interferes extremely with the quality and the economy of all iron-making concerns, irrespective of locality or compositions of the iron ores or the fuel they have to produce iron from. Fibrous iron, he said, will not give satisfaction when used for sledge hammers, pile shoe tips, or similar uses that have to stand this special kind of impact or crushing force. Iron may be as good as need be for some purposes and the same iron quite useless for others. The ironmaker is at fault if he sends to a first-class shoeing smith redshort iron, or coldshort iron to a chainmaker, when the price paid for it commands suitable iron. And the blacksmith is at fault if he attempts to work a piece of iron on an anvil before it is thoroughly hot in the middle; or if, after he has forged the iron into shape, he bends it into form at a low red heat. The opinion was expressed by Mr. Morris that a smith who cannot spoil at will any iron that is given to him is not fit to stand in front of a smithy fire. Latterly some consumers of iron are stating what special or general purposes the iron they are ordering will be used for. This is very exemplary and must in the long run bring more profit and less plague to those gentlemen.

ENGINEERS' CLUB OF PHILADELPHIA.—At the fifteenth annual meeting, Jan. 21, President James Christie in the chair, 52 members and visitors present, Mr. James Christie, President, read his annual address, in which he called attention to the diversities of interest represented in the club, and the advantages accruing to members of an interchange of thought and experience. He gave a historical outline of the progress of engineering from early times, and of its present needs and prospects in its various departments. The annual report of the directors showed that during the year 64 active and 3 associate members have been elected. The list of members at the close of 1892, stood as follows:

	Resident.	Non-resident.	Total.
Honorary	0	1	1
Active	264	177	441
Associate	12	3	15
	276	181	457

The following officers were elected for 1893: President, John Birkinbine; Vice-President, James Christie; Treasurer, T. Carpenter Smith; Secretary, L. F. Rondinella; Directors, Henry J. Hartley, John L. Gill, Jr., and W. B. Riegner.

WESTERN RAILWAY CLUB.—At the meeting on Jan. 17, a paper on "Wheel Flanges" was read by Mr. G. W. Rhodes. We reprint it in another column.

NEW ENGLAND WATER-WORKS ASSOCIATION. The adjourned quarterly meeting will be held at the Parker House, Boston, Mass., Feb. 8. By invitation of S. F. Pierson, Chief Engineer, arrangements have been made for a visit to the power station of the West End Ry. Co. At 11 a. m. the rooms at the Parker House will be opened for the use of the members, and 12:30 p. m. there will be a meeting of the Executive Committee. Lunch will be served at 1, and reading and discussion of papers will begin at 2. A paper on "Stand-Pipes, Their Construction and Design," will be read by Freeman C. Coffin, and this will be followed by brief experience talks.

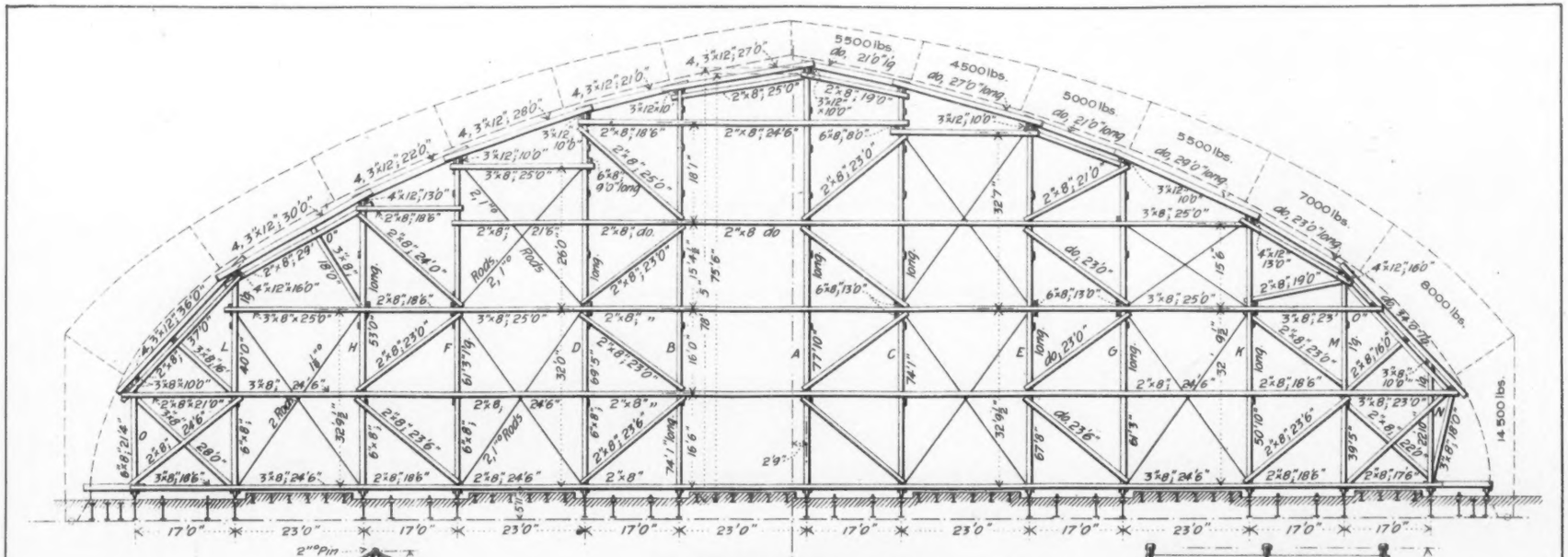
R. C. P. Coggeshall, Secy.

New Bedford, Mass.

CENTRAL RAILWAY CLUB.—The annual meeting and banquet was held on Jan. 25, at the Iroquois Hotel, Buffalo. The present membership is 154, a gain of 11½% during the year. The proper method to be followed where partial repairs are made on a car having a defect card was reported on by a committee. To follow the rules at present in force it is necessary to hold the car, make the necessary repairs and return the original card to the party who applied it, asking him to send you in exchange two cards, one covering repairs made, the other covering repairs not made. The committee said that this would cause such delays as to make it manifestly impracticable, and proposed amendments to the rules to simplify the procedure. Mr. Mackenzie proposed as a still simpler solution of the problem that when partial repairs are made a new card should be attached to the car stating what were the original defects and what repairs have been made. In the discussion the principal point brought out was the general neglect of inspection and repairs of air brakes. The following officers were elected: President, A. M. Waitt, Lake Shore; Vice-President, S. Higgins, Erie; Secretary and Treasurer, S. W. Spear, Buffalo.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
Feb. 4. 1122 Girard St., Secy., L. F. Rondinella.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 4. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB.
Feb. 4. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 6. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 7. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Feb. 7. Secy., W. Hallburton.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 8. Wichita, Kan.
NEW ENGLAND WATER-WORKS ASSOCIATION.
Feb. 8. Parker House, Boston, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 9. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Feb. 9. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Feb. 9. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Feb. 10. Secy., D. W. Meeker, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
Feb. 13. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 13. Secy., Waterman Stone, Baird Building.
DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 14. Secy., F. E. King, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Feb. 14. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
Feb. 14. Union Station, St. Paul. Secy., W. D. Crosman.
ENGINEERS' CLUB OF ST. LOUIS.
Feb. 15. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Feb. 15. Secy., F. Collingwood, 127 East 23d St., New York.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Feb. 15. Secy., S. E. Tinkham, 36 Broomfield St.
NEW YORK RAILROAD CLUB.
Feb. 16. Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Feb. 16. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Feb. 16. Secy., C. P. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Feb. 17. 201 Washington Building.
WESTERN RAILWAY CLUB.
Feb. 21. Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Feb. 21. Secy., R. H. Clark, Pittsburg.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W. Raymond, 6 Burling Slip, New York, N. Y.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Feb. 24. Secy., C. H. McLeod, Montreal, P. Q.
WESTERN SOCIETY OF ENGINEERS.
March 1. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 3. Secy., E. K. Smoot, 805 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 3. Secy., O. Von Geldern, 719 Market St., San Francisco.
NEW ENGLAND RAILROAD CLUB.
March 8. Secy., F. M. Curtis, O. C. R. R., Boston.
CENTRAL RAILWAY CLUB.
March 22. Secy., S. W. Spear, Buffalo, N. Y.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20, Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.



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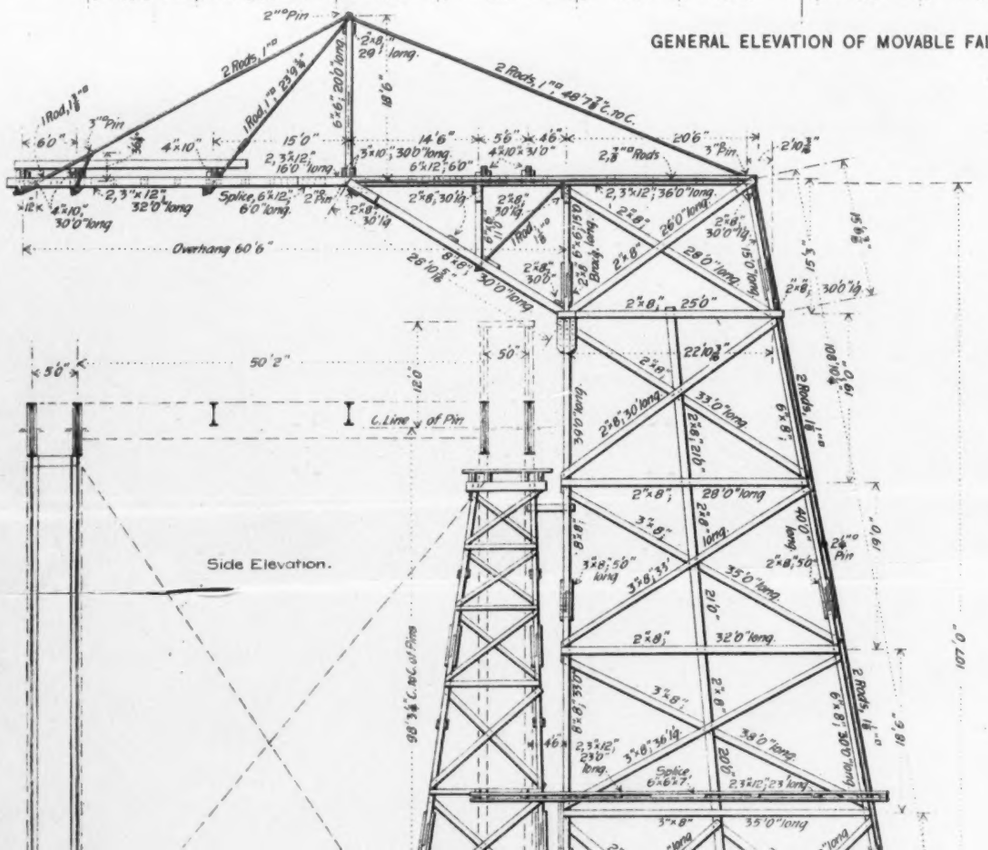
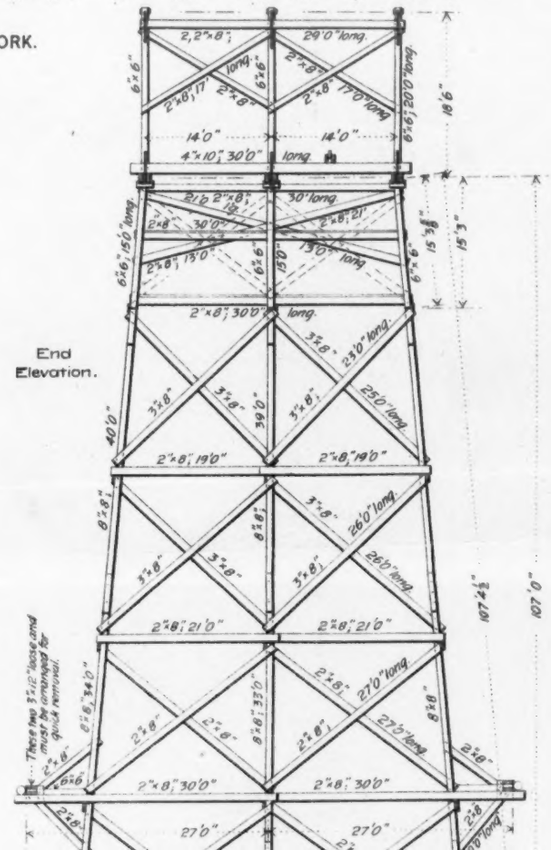
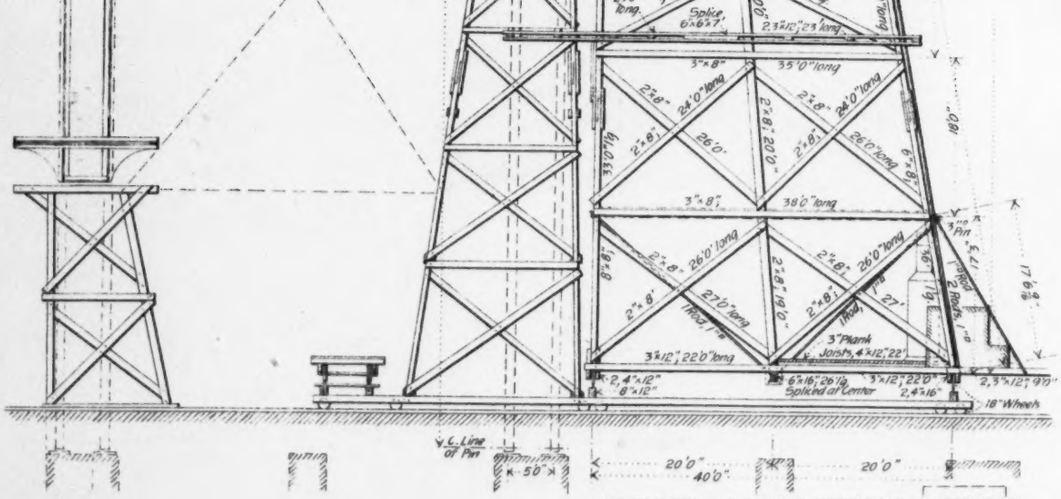
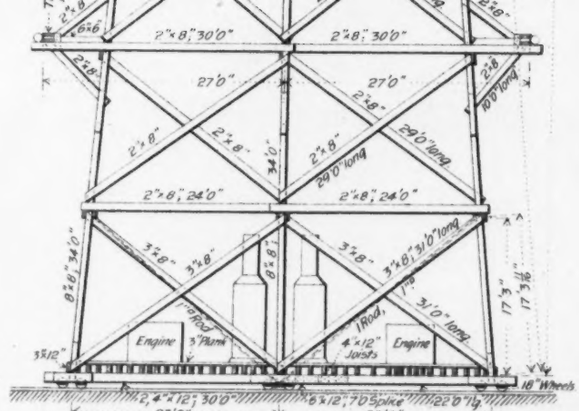
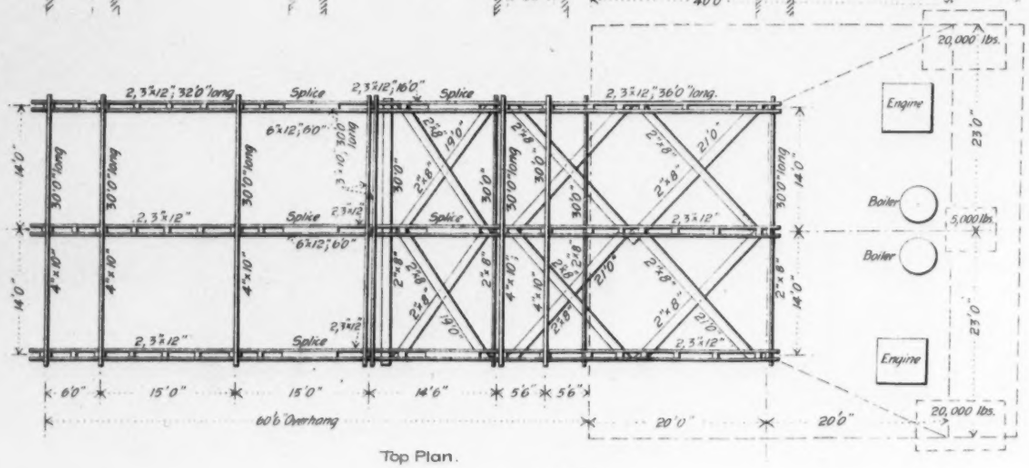










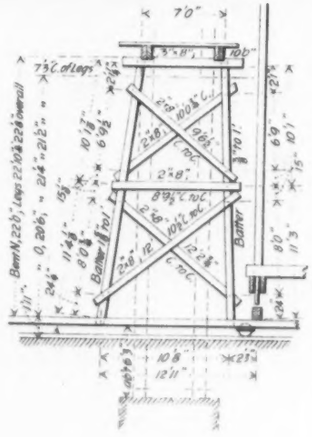
Top Plan.

DETAILS OF TRAVELER.

MOVABLE FALSE WORK AND TRAVELER FOR ERECTING PHILADELPHIA & READING TERMINAL R. R. TRAINSHED.

Phoenix Bridge Co., Contractors;

A. Bonzano, Chief Engineer.



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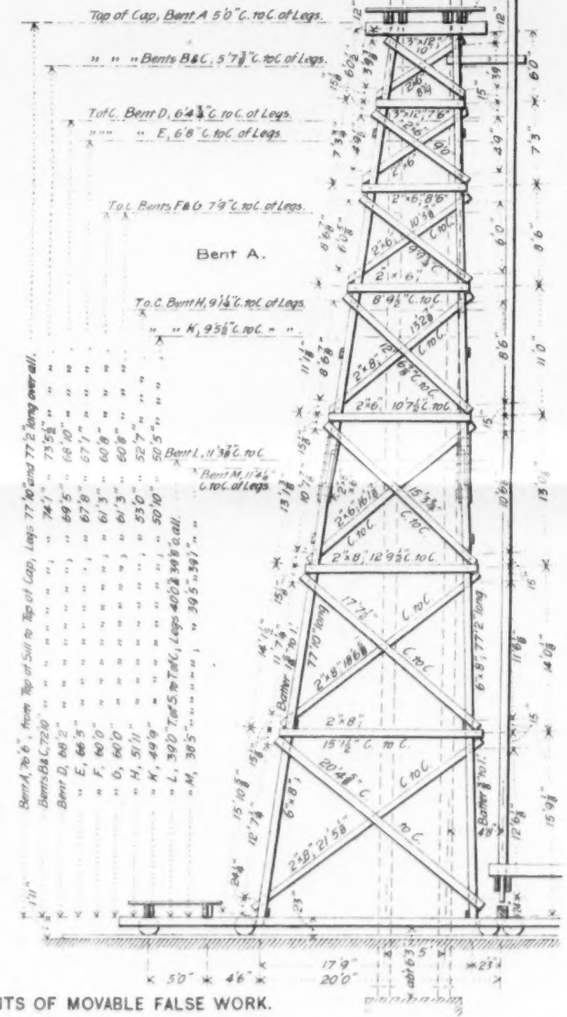

DETAILS OF BENTS OF MOVABLE FALSE WORK.

CHAS. HART & SONS, LITH. 56 VESEY ST., N. Y.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

In comment upon the automatic signal plant of the Central R. R. of New Jersey, on p. 86 of our issue of Jan. 26 it was incorrectly stated that the distance of 60 ft. between the signal and rear of train had no particular significance. As a matter of fact, the track connections to operate the signals of the two blocks in the rear are, as a rule, set never less than 60 ft beyond the signal. In other words, the last car of a train must pass 60 ft. beyond the signal before the third signal behind it is released, the second signal behind it is set at caution, and the first signal behind it is set at absolute danger. There are a few signal posts where the track connection for releasing and setting the signal behind it is as much as 150 ft. beyond the signal, but this is only in cases where the blocks are short. It will be seen, therefore, that as long as enginemen obey the rule to stop in front of a home signal at danger there is a clearance of at least 60 ft. between trains.

The paper on wheel flanges, by Mr. G. W. Rhodes, which we publish in this issue, is one which deserves most careful study by every one concerned with either railway rolling stock or maintenance of way. As the paper clearly points out, the wheels and the track form parts of one machine; and if their dimensions do not properly correspond, trouble is certain to result. It is remarkable, indeed, that with the standard gage of track varying all the way from 4 ft. 8½ ins. to 4 ft. 9 ins., to say nothing of the variations made by track foremen at curves and turnouts, there should be so few derailments in railway service, although compared with English practice our proportion of derailments is very high. The evil results of allowing the wide variation of ¾ in. for width between the backs of wheels have been pointed out before; but the question should be agitated until these needlessly wide limits are cut down. Fortunately, however, a large part of the trouble will soon be removed by the elimination of the 4 ft. 9 in. gage on the Pennsylvania Railroad, which is now in progress, and which we are informed is likely to be pushed rapidly forward to completion. The example of this company ought to be followed by the others which still adhere to this gage.

A new constitution for the Canadian Society of Civil Engineers, increasing the qualifications somewhat, but not otherwise modifying materially the organization or management of the society, is out for ballot. The provisions for branches, which are only slightly modified from those which have been long in force, are as follows. We give them as well worthy of imitation, it would seem, by the American Society of Civil Engineers, as meeting sufficiently well the wishes of those who believe in branches, while avoiding all the more serious objections which have been raised against such action:

49. A local branch of the society may be established under the authority of the council at the request of not fewer than ten voting members, who are desirous of forming themselves into such local branch, in any place not less than 100 miles from the headquarters of the society, or from any existing branch. The members of such branches shall consist of those who join from time to time. The establishment of a branch shall not release members from any of their obligations to the society, whether as regards fees or membership in any class.

50. Local branches, although formed strictly of members of the society, may be distinguished by the name of their locality, as for example, "The ..... Branch of the Canadian Society of Civil Engineers."

51. The officers of local branches shall be a chairman and secretary-treasurer, who shall be elected by the members of the branch.

52. All classes of members of local branches must have been elected by the society in the usual way, and in no case shall their members be added to locally or otherwise than in the regularly prescribed way.

53. Members of a local branch shall pay to the society the fees of a resident member of the society, and the society shall remit to the branch, on application of its secretary-treasurer, the difference between a resident and non-resident's fees. The society shall not be liable for any expenses incurred by a branch.

54. The regular meetings in all branches shall be held on the same date as the corresponding meetings of the society at headquarters.

55. In by-laws, rules of order, etc., and in particulars not specially referred to, the branches shall conform to the methods and rules adopted by the society.

The difficulty which Englishmen so often find in grasping the most simple facts about this country, and the readiness of man to "draw upon his imagination for his facts," even in serious statistical articles, is amusingly illustrated by a statement which we chance to note in the last number of "Engineering" in a series of articles on "American Industries and British Commerce," now running in that journal. The writer says:

> The population of America has grown with unparalleled rapidity, due more to immigration than to natural increase. The immigrants who have constituted during recent years seven-eighths of the increase in the adult population, are as a rule uneducated," etc.

So far is this statement from being true that the United States has always had, and has now, the largest ratio of natural increase of any large and civilized country in the world. The mean ratio of 2% per annum for natural increase, plus the immigration corrected for deaths, checks almost exactly on the population shown by the successive decennial censuses since 1790, with the sole exception of the war decade and the one just ended. In 1850, when the ratio of immigration increase was about at its maximum, our population was 23,200,000, of which a little over 25% were adult males, or nearly 6,000,000, 2% of which is 120,000, natural yearly increase of adult male population. The immigration was then running about 300,000, of which about 40% were adult males, or 120,000 per annum. Coming down to the most recent figures, the increase in native-born population between 1880 and 1890 was from 43 to 53 millions, or exactly 9,896,863; in foreign born, from 6.7 to 9.2 millions, or exactly 2,569,604. In the previous decade the native born increase was 10,484,700, against 1,112,700 by immigration. Making all allowance for the larger percentage of adult males among the immigrant increase, these figures indicate that not much over one-fourth, instead of "seven-eighths" of our adult male increase is due to immigration, and when we further consider how large a proportion of this immigration is from Canada and Great Britain, which is foreign only in name, the misinformation conveyed in the above statement is still more evident.

That this carelessness of statement is not exceptional is shown on the very next page by the following note as to a diagram showing our national receipts and expenses:

> We have shown on the diagram by a dotted line what customs contribute to revenue, but if customs were to be reduced to comply with the idea of a tariff for revenue only then they would contribute the sums shown by the dash and dotted curve, the lowest on the diagram.

Any one who can tell in advance what our tariff would produce if modified to comply with an idea ought not to be permitted to waste his sweetness upon London. There is a yawning void for him on this side of the water as consulting prophet to the incoming administration.

The almost utter lack of business principles, as well as common sense, displayed by municipal authorities in granting franchises is well illustrated by the following copy of an official publication of an ordinance granting a franchise to the company named, Hyndman being a Pennsylvania borough:

> Be it ordained by the burgess and town council of Hyndman borough that the Hyndman Electric Light, Heat & Power Co. shall have from and after the passage of this ordinance the right and privilege and the consent of said council to erect, maintain and operate within the limits of said borough of Hyndman its buildings, machinery and other appliances necessary to furnish light, heat and power by means of electricity and steam to such persons, partnerships and corporations residing in and adjoining to said borough as may desire the same, at such price as may be agreed upon, and for this purpose the said Hyndman Electric Light, Heat & Power Co. has the consent of the said burgess and council to enter upon any street, lane or alley in said borough and erect poles and run wires on the same over the said streets, lanes and alleys in such numbers and sizes as they from time to time may deem necessary, and to remove such obstructions as may interfere with the erection of the poles or the proper working of the wires; the location of the poles to be subject to the control and supervision of the council. . . . . .
> Attest: Burgess.
> . . . . .
> Secretary.

As showing the attitude which some of the newspapers of the country are taking on the subject of municipal franchises the following comment on the above ordinance is reprinted from the "Commercial," of Meyersdale, Pa.:

> It will be noticed this ordinance "gives the earth," and that the only right reserved by the council is the location of the poles. It's a wonder they had the nerve to ask that favor from the masters their ordinance created. Now, here is every valuable right and privilege of the people granted for eternity. No protection as to price; that is all left to the tender mercies of the light corporation, and we all know how tender they are. In fact, Hyndman has no remedy at all, if such a wonderful ordinance would stand the fire of judicial investigation, which we do not think it would. Once again, guard all your rights and privileges; make your franchises pay; insist on the smallest time limit; finally get to own the plant, as a borough, soon as you can.

The form of publication does not indicate whether the ordinance had already been passed by the borough, or whether it was merely being officially published prior to consideration for passage. The mere fact that such an ordinance can find its way before a municipal council is itself a commentary upon the general public opinion of the relation between municipalities and corporations performing public functions.

DEGREES AT SCIENTIFIC SCHOOLS.

We have ventured to remove from the end of a letter from Gen. Francis A. Walker, President of the Massachusetts Institute of Technology, published in our last issue and relating to an entirely different matter, the following comment in respect to the question of college degrees. It appeared more convenient to publish this paragraph here, as it seemed to call upon us to define our position.

> While I am writing, permit me to say that I fail to see the reason for the warmth displayed by Engineering News in regard to the degree of "Master of Science," given to advanced students in this school. It is admitted that our Bachelor's degree is given upon a very high scale of attainment, which Engineering News has most generously recognized. To our minds, the degree of Master of Science stands in the same relation to the Bachelor of Science degree as the degree of Master of Arts stands in toward the Bachelor of Arts degree. Nobody is going to suppose that, because a young man receives the degree of Master of Science from this or any other school, he is really master of all science, any more than he is going to attribute to the possessor of a Master of Arts degree from Harvard or Yale the mastery of all arts. The Master's degree is something that has been made familiar to the public mind from the very foundation of our oldest colleges; and we see no reason why it should not be given on substantially the same terms in science as in the arts.
>
> Respectfully yours,
> Francis A. Walker.
>
> Boston, Mass., Jan. 18, 1893.

As we think we do see a reason why there should be a distinction between the two cases, we will endeavor to make clear what it is. We are not aware of any college which confers the degree of "Master of Arts." The degree usually con-

ferred, at any rate, is that of "Artium Magister" (A. M.), which has come down to us from the days when it involved no great stretch of the imagination to believe that those who received it actually were masters of all the "artes" there were; by which term was meant then only logic, rhetoric, arithmetic, etc., and not what we now understand by arts. By its long use in this sense, the term has become "polarized," so that it does not now mean what it says, but something very different. If there were no such inherited custom and inherited sense of the meaning of the term, a proposition to begin to-day conferring the title would be greeted with universal ridicule and disapproval. The custom, moreover, dates back to the time when exactitude of statement was deemed less essential than to-day.

But science is a thing of to-day and not of the past, and schools of science especially should, as a matter of morals, be governed by the ideas and customs of to-day in respect to accuracy of statement; and, as a matter of taste, should avoid any chance of making themselves ridiculous by aping traditions and customs in which they do not share. Calling any man a "Master of Science" is stating what is untrue, and known to be so, whether "master" be interpreted in the literal and actual sense, or in the derived sense preserved in the word "magistrate." Therefore we object to it. We are not aware of having shown any "warmth" about it. We are frank to say that the ludicrous incongruity between the facts and the title seems to us the chief objection to its use, and yet we contend that there is a moral issue also. The very soul of modern science is rigid exactitude of statement. Let our schools of science at least respect this principle, and not teach their students by example that it does no harm to be a little loose in statement (to put it mildly), if they go no further than some other people did, some centuries ago. The Massachusetts Institute of Technology has nobly recognized this principle by refusing to confer degrees of C. E. and the like on undergraduates. We cordially recognize that fact. Whether it might not go a little further in the same direction, however, is the only question at issue.

As we would not appear simply as carpers or critics, but recognize that we should show what better can be done when complaining of what is, we will state frankly what seems to us the proper course to adopt in regard to this vexed question of degrees. Accepting as a fundamental principle that truth should be rigidly respected in conferring all degrees, in scientific courses at least, but remembering, on the other hand, that suitable degrees should exist for varying scholastic acquirements, the following seem to us both suitable and unobjectionable. We wish that all our colleges would accept them, or that the stronger ones would, by common agreement, compel the weaker ones to do so; for the weaker ones are the most likely of all to insist on loud-sounding degrees.

For the undergraduate degrees it seems to us that B. C. E., B. M. E., B. E. E. etc., are the proper ones for those who take the professional courses, reserving the degree of B. S. for those only who take the so-called "general course" with a view to teaching or business life. The B. S. degree has been so "soiled by all ignoble use" in recent years that it means absolutely nothing as to professional training: not only all the engineering schools, over 100 in all, confer the degree, but 200 or more other colleges which (many of them) give only a smattering of textbook instruction, confer it also. If degrees are of any real use to graduates, it is hardly fair to give men who have had a sound professional training so unmeaning a degree. If they are of no real use to the graduate, let us at least tell the truth in them! The degrees suggested are definitive, exactly truthful, and sufficiently loud sounding for those who seek for that element.

For postgraduate degrees, in our judgment, the proper one in the professional courses is that of "Civil Engineer," etc., conferred when he is one! By this we do not mean that he must first rise to the top of his profession, but that he shall have had at least two years of practice and one of study, or three years of practice, since he graduated. If colleges choose to confer the degree of D. C. E. where special honor is warranted, following present usage in respect to LL.D. or D.D., there certainly can be no objection to it, since "Doctor" means, and is understood to mean, nothing but "learned" or "instructed."

We do not forget that in medieval usage "doctor" and "magister" were almost interchangeable terms. They were not equivalents in original meaning, however, nor are they equivalents when translated into modern English.

In certain courses, as in chemistry, it might even be necessary and proper to give this "Doctor" degree after a few years of practice, without further study, and the only objection to making this the general postgraduate degree is that it would cheapen the title and make it absurd.

As for the "general science" men, they are and will ever be (so far as their college training goes) nothing but smatterers. Let them have their B. S. degree when they graduate, and let them get their M. S. degree when they show that they are such, and not before. They are apt to be the most hungry of all for degrees, however, and if for them it seems necessary to keep the M. S. degree; let us at least turn the lie into Latin and make it S. M.! It seems less offensive to tell lies in Latin; it seems medieval and fitting; but lies told in modern English and solemnly attested seem—well, rather bad form, to say the least, and rather bad morals, as well, according to modern ideas.

BRIDGE PIERS IN THE NORTH RIVER.

The North, or Hudson River, at New York city, is the principal harbor of the United States. Its navigation has distinctly the character of harbor navigation, combined with river navigation, that is, the vessels not only pass up and down, as on a river, but crosswise, from shore to shore, and diagonally, as in a harbor. The large ocean steamships must have room to swing in and out of their docks and slips, and chiefly for this reason the anchoring of vessels in the river is prohibited. Some of these steamers are 560 ft. long, and steamers will undoubtedly soon appear of a length of over 600 ft., requiring the full unobstructed width of the river at any point for their evolutions. Two of the White Star steamers are 582 ft. long, two of the Inman steamers, 565 ft., while the new Cunard steamers will be 620 ft. long, and the new Inman steamers probably about the same length. From year to year the region devoted to wharves and docks is extending upward, and probably will in future require the entire water front of the city. Besides, the United States government is cutting a canal from the North River to the Harlem River for the purpose of giving direct entrance to ocean craft from Long Island Sound through the Harlem River into the North River, which will thus more than ever require to be free from mid-river obstructions. The time of greatest danger to navigation is during the frequent fogs in the harbor. Collisions are of almost daily occurrence, in spite of all possible precautions, as shown by the reports of the Chief of Engineers, United States Army, but a collision of two ships can never be so disastrous as a collision of ship and bridge pier. The manœuvring and steering of vessels intersecting each other's courses is very much complicated by any immovable obstruction, such as bridge piers in a harbor, even in clear weather, and becomes a matter of very serious danger in icy or foggy weather. So much so, that if nature had planted piers or rock islands in the North River, the government would long ago have expended hundreds of thousands of dollars, if necessary, for their removal, as it did at Hell Gate, with less than one-tenth of the prospective commerce.

For these reasons, whatever else may be done about bridging the North River, we trust it will always be insisted on that it shall be bridged, if bridged at all, by a single span from pier line to pier line; because it is undoubtedly within the resources of engineers at the present time to build such a bridge without any very heavy increase of expense. There is an evident effort at the present time to acquire powers of construction which do not contain this proviso. They should never be granted.

It has been said that a bridge pier is no more of an obstruction than a ship at anchor. This is not correct. A ship at anchor does not disturb the regimen of the currents, or of the river, but a bridge pier does, necessarily, because it must reach to the bottom of the river, diminishing the cross-section of mid-river, where it affects most vitally the tidal currents either way, for which allowance must be made by the navigator. In foggy weather the obstruction is not visible, its disturbing effect cannot be promptly judged, and disastrous collisions may be the result.

The dimensions of such a bridge pier in the North River can certainly not be less than those of the Brooklyn Bridge, 140 × 60 ft., near the water line, but on account of the more exposed location to wind storms, it must be made larger. It was necessary in the case of the Forth Bridge, in Scotland, for this reason, to make the towers very wide at the base, requiring a group of four piers, each 80 ft. in diameter, and the middle tower occupying an area of 430 × 230 ft., for which an existing rocky island was utilized. The base of the tower, however, was made for safety larger than the width of the Inchgarvie island. A bridge pier in the North River would for safety likewise require to be as large as a good-sized island. The two piers for the North River Bridge, already authorized, are to be 340 × 180 ft., but they will be located on the edge of the water within the pierhead lines, and no piers or other obstructions are allowed anywhere in the river itself.

That there is no real necessity whatever for bridge piers in the North River at New York city is shown by experience in building great bridges. The oft-expressed judgment on this question of the government engineers of the War Department is founded on indisputably correct engineering and economic grounds. Their record on bridge requirements is a most remarkable one for the foresight and progress shown. It is their achievement that they insisted on 500-ft. channel spans for railway bridges over the Ohio River, 22 years ago, when almost all other bridge engineers held that it was impossible to build them. But after the law's enactment, as recommended by the War Department, the bridges were built accordingly, and it is a noteworthy fact in this connection, that at this time such a long span can be built for less than one-half the cost of the first ones. For instance, the Cincinnati Southern R. R. bridge, built 18 years ago, cost about $760 per lin. ft. of the 500-ft. span for sub-structure and superstructure, while the similar cost for the Ohio River bridge, at Pittsburg, was only $340 in the year 1891. Similar Ohio River bridges are now built almost every year. The government engineers prescribed a 700-ft. span for the Memphis railway bridge over the Mississippi River. It was strenuously objected to, but finally built without difficulty. They prescribed a 1,000-ft. span at New Orleans, for a bridge to be located above that city, and there will be no difficulty whatever in building it.

When the Brooklyn bridge was proposed with one single span of 1,600 ft. across the entire East River, the great majority of engineers in this country expressed their serious doubts as to its practicability. It was approved and built, and can now be duplicated for less than one-half the cost. The government engineers, during the month of January, approved two more proposed single-span bridges over the East River, between New York and Brooklyn. The North River bridge, authorized by act of Congress, and approved by the Secretary of War, with a single span over the North River of 3,100 ft., is the latest example of bridge progress, and we see no reason to believe that there will be any more engineering difficulty in building it, or even as much, as in the case of the Brooklyn Bridge.

There is no economical waste in this requirement of the War Department; for the estimates of the North River Bridge Co., on file with the Interstate Commerce Commission, indicate that the cost per lineal foot of track of the North River bridge will not be as large as that of the Memphis bridge for substructure and superstructure, not over $300 per foot of track, which is the best unit for comparisons of cost of bridge construction. This bridge is designed for 14 tracks, eight of which will be laid at first, and the others added as required for an increasing traffic. The plans are fully worked out, and we have no reason to doubt their correctness and absolute safety; though some statements to the contrary have been disseminated by a rival project.

One bridge across the North River, of the dimensions and capacity demanded by the conditions

here set forth, would cost so much money that capital would hardly furnish the means for erecting another by its side, which would merely divide prospective income. But whichever of the two present companies finally bridges the North River, let it be a fixed condition that the plan adopted shall leave the harbor of New York absolutely untramelled to navigation and to the movement of ocean steamers of yet unknown length. And this advice applies to the harbor of the future New York, which will doubtless extend to the Harlem River, or beyond. This is the view wisely taken by the War Department in its past dealings with proposed structures across this river, and there is every good reason why Congress should adhere strictly to the precedent thus established.

The commerce of the North River, including all traffic, is now said to be eight times that of the Mersey River, at Liverpool, and it is futile even to guess at its possible growth in the near future. Yet the English government forbade the bridging of the Mersey, and compelled a tunnel under the river. Americans would doubtless be pleased to see a 3,100-ft. bridge spanning the North River as an exhibit of the latest development of modern bridge engineering. The danger and folly of denying the possibility of erecting a bridge of this span to-day is shown by the fact that in 1868, 26 of the then leading bridge builders and engineers of this country signed a declaration stating that the 550 ft. span proposed by Captain Eads for the St. Louis bridge was impracticable and purely visionary; and he was further derided and libelled for proposing to use steel for his material. Yet this bridge was built, and steel is now almost the only material used in long span bridges. The fact that a bridge has been built just above the St. Louis bridge, 20 years later, for one-third the cost, and that the Brooklyn Bridge could be duplicated for one-half its cost, only mark the advance made since 1868. The span proposed for the North River bridge is a daring leap into the future; but what unprejudiced engineer would care to record himself as against its engineering possibility, in the light of past experience, and the present rate of advance in our knowledge of materials?

THE FIRST INVENTOR OF THE INCANDESCENT LAMP.

A sensation has been caused in electrical circles by the alleged discovery of an inventor of the incandescent lamp who antedates Edison by many years. As announced in our issue of Oct. 6, 1892, the Edison patent, No. 223,898, on the incandescent lamp was sustained in the court of last resort by a decision handed down Oct. 4, and since that date injunction after injunction has been secured, closing the works of incandescent lamp makers. But in the suit of the General Electric Co. against the Beacon Vacuum Pump Co., of Boston, the defendants gave the plaintiffs a great surprise by bringing forward affidavits from numerous witnesses alleging that one Henry Goebel, a German instrument maker, invented and made incandescent lamps similar in all essential details to the lamp described in the Edison patent, as long ago as 1855. Goebel emigrated from Germany to the United States in 1848, settled in New York city, and soon began experimenting with electrical apparatus. In the years before the war he operated a portable astronomical observatory, consisting of a telescope 15 or 20 ft. in length, mounted on a wagon, which, on pleasant summer evenings, would be stationed in some open space in the uptown streets, uptown then signifying locations no farther north than Union Square or Astor Place. To attract the attention of passers-by, Goebel was accutomed to display two or three of his incandescent lamps, current for which was furnished from batteries placed underneath the driver's seat. It is thus seen that Goebel made no secret of his invention, and until his removal from his shop in Monroe St., which he occupied for more than a score of years, he continued to make lamps and publicly exhibit them. In 1881, soon after Edison's invention was made public, a company known as the American Electric Light Co. was organized to make incandescent lamps, and Goebel was employed to make carbons for the company and produced excellent work until the company failed. Why the fact of Goebel's anticipation of the Edison patent was not then made public does not yet appear.

The history of Goebel's invention was given in great detail in 28 affidavits, which were filed by the Beacon Co., as its defense in the proceedings for an injunction brought by the General Electric Co. Besides the affidavit of the inventor himself, testimony was taken of several of his children and many of his neighbors, who were familiar with his work, also of Prof. Charles R. Cross, of the Massachusetts Institute of Technology, and of Mr. Franklin L. Pope. After hearing arguments from the counsel on both sides the court granted a week's time for the filing of briefs and such further affidavits as each side may desire. It is certain that this remarkable case of prior invention will be thoroughly investigated, and the extent of Goebel's work will be determined.

The new lamp of the Westinghouse Co. also promises to lead to further litigation with the General Electric Co. The new lamp differs from the Edison or common lamp in being made in two parts, like a bottle and stopper. The joint between the two is made by a cement. The Westinghouse Co. probably rely on the fact that the stopper can be made of porcelain or some material other than glass to defend themselves from the charge of infringement, as the Edison claim which has been sustained is for a carbon filament in a vacuum chamber made entirely of glass.

The Syria-Ottoman Railway, from Haifa to Damascus (Eng. News, Dec. 15, 1892), will be 130 miles long, of standard gage. Work has been commenced; the ceremony of turning the first sod being accomplished by the sacrifice of sheep, and the saturation of the earth with their blood. Leaving the Bay of Akka, the line will skirt the Carmel range to the Esdraelon Valley, touching at Nazareth, and crossing the river Jordan at the south end of Lake Tiberias, whence it will run by the Hauran plains to Damascus. The district traversed is said to be very rich and fertile.

Tunnel ventilation will have to be provided for in the long tunnels of the new Dore & Chinley branch of the Midland Ry., of England (Eng. News, Nov. 17, 1892), as, according to the "Railway News," it is very difficult to get the smoke out of the tunnels, and the Midland Ry. will, it is understood, cut a heading along the side from end to end, by means of which it may be carried off. This will be a work of some magnitude, and it is expected that a number of men will be employed on the work for upward of twelve months longer. This project, it is considered, will not be so expensive as sinking more air shafts from the summits of the hills.

The Pottstown Iron Co., of Pottstown, Pa., was placed in a receiver's hands on Jan. 30. The company has over $3,000,000 invested in its plant, and is notable as being the only works in America which has made steel successfully by the basic Bessemer process. Although this steel plant has been made a success technically, the large expenditures in its development are alleged to be one reason of the company's financial difficulties.

A single-screw steamer has again beaten a twin-screw of the latest type in a race across the Atlantic. The "Etruria" of the Cunard line left Queenstown on Jan. 22, and three hours later the "Fuerst Bismarck," of the Hamburg-American line left Southampton, 300 miles further east. The "Etruria" arrived at New York 28 hours, 10 minutes ahead of the twin-screw vessel, while the best records between the two routes differ by only 10 hours. The Hamburg-American boat, however, had an unusually rough passage.

The rain makers can no longer pursue their Fourth of July experiments at government expense. The House Committee on Agriculture has refused to make further appropriations for rain making experiments.

An underground electric railway is proposed for Brussels, and will be a belt line having eleven stations. Each train will consist of only one car, on four-wheel trucks, with motors on one truck. There will be first and second class compartments, accommodating 40 passengers, with a compartment in front for the engineman or operator. It is proposed to run eleven such cars in each direction, and to work the traffic by the automatic electric block system, as adopted on the Liverpool electric elevated railway. The elevators at each station will be operated by electric power. Mr. J. H. Greathead is the engineer.

The Massachusetts Board of Highway Commissioners will argue, in their forthcoming report, that if towns will spend $1,500 in modern road machinery they would save an average of $1,000 annually in labor and material.

LETTERS TO THE EDITOR.

CONTINUOUS RAILS.

Sir: Noting the remarks in your issue of Jan. 12 on "Continuous Rails," describing the case of the Richmond & Durham R. R., I hasten to advise you that in a discussion by Mr. Chas. S. Churchill, read at the Engineers' Club of Philadelphia a week ago, Mr. Churchill gave a by no means encouraging account of the present condition of that piece of road. I do not remember the exact statement, but I think a note addressed to Mr. Churchill, Norfolk & Western R. R., Roanoke, Va., would elicit information worth having in this connection.

On the other hand, Mr. Gleaves (R. Taylor—not T. Taylor, as you have it) wrote me Nov. 7 last (1892) "The three miles on the Lynchburg & Durham R. R. are still in good condition and have not been disturbed." He also writes: "Last summer (he must mean summer of 1891) I built a double track electric railway, and used 45-lb. T rail. I did not provide for expansion, and a service covering two summers and one winter has not shown any defect." See correspondence of mine with Brinckerhoff, in "Street Railway Journal," this month, page 33, giving abstract of discussions before Institution of Civil Engineers and Franklin Institute some 40 years ago on same subject, participated in by Brunel, Hawkshaw, Ellwood Morris and J. Dutton Steele.

Yours truly, John C. Trautwine, Jr.

Philadelphia, Pa., Jan. 15, 1893.

(We give below a communication from Mr. Churchill on this subject.—Ed.)

Sir: I beg to state that the article in Engineering News of Jan. 10, on "Continuous Rails for Railways," as far at least as it relates to a certain experiment made on the Lynchburg & Durham R. R., does not represent the facts at this date.

In the discussion of my paper on "High Speeds on Railways from a Maintenance of Way and Engineering Standpoint," before the Engineers' Club of Philadelphia (an abstract of which is given in another column.—Ed.), Mr. Jno. C. Trautwine remarked that "the author makes no allusion to the question as to whether continuous rails are generally practicable." This query of Mr. Trautwine, among others, was answered under date of Dec. 31, which answer in full was presented in the Engineers' Club of Philadelphia at the meeting of Jan. 7. The answer to this one query was as follows:

"As to the possibility of securing continuous rail, I do not think it is probable in connection with railways. It is more possible with street railways, as the traffic and loads are very light compared with railways; and, as the rail is very much protected from effects of the temperature by being surrounded by paving.

The experiment made by Mr. Gleaves, near Lynchburg, was on the Lynchburg & Durham R. R. That road is now one of the leased lines of the Norfolk & Western R. R., and consequently I am prepared to give the results of that experiment.

I made a personal examination of this experimental track during November, 1891. My report reads as follows:

"Near Gladys is a section of three miles of track put up on the so-called 'Noonan system.' The rails have been riveted together at the joints for the whole distance of three miles, and at each end of the three mile section is a point switch arranged so as to take up the expansion of the three miles of continuous rail. None of the rails are spiked close to the ties, but there is a little play allowed between the flange of the rail and the underside of the spike head. The ties are completely covered with light earth from the adjacent cuts; in fact, nothing is seen on this section of track excepting the heads of the rails. This track was put up about 1½ years ago. It is now, however, in poor line and surface and it will soon be necessary to remove all the top filling and re-surface it, the same as any piece of track. The only advantage secured, therefore, by this system of track is smoothness at the joints due to the rails being riveted together."

I have a report to-day from the Superintendent of the Durham Division (the old L. & D. R. R.), of our road in regard to this piece of track. It is as follows:

"Owing to the ties being buried they are water sogged, consequently they are very much sap-rotted, and probably 50% of them will have to be renewed during 1893. The expansion switch points evidently do not work satisfactorily, as the track is badly kinked, more especially during summer. Track also gets out of surface frequently, so you can well imagine what an expensive job it is to re-surface it."

From the above it is to be noted:

1. That ties are quickly destroyed when covered in the manner required in the so-called "Noonan track."

2. That expansion of rails cannot be disregarded even though the track is buried as much as possible, and thus protected from the changes of temperature.

3. Expansion of a long section of track cannot be carried successfully to one point, even when spikes are kept loose for the purpose.

4. The track does not remain in surface even under

comparatively light traffic, as well as ordinary track, and it is very expensive to restore it to surface.

5. Therefore, the experimental "Noonan track" is a failure.

Yours truly,

Chas. S. Churchill.

Engineer of Maint. of Way, N. & W. R. R.

Roanoke, Va., Jan. 26.

THE EMPLOYMENT OF ENGINEERS ON ENGINEERING BOARDS.

Sir: I should like to ascertain the composition of the boards of large engineering propositions such as the Croton Aqueduct Commission, the Chicago River Drainage Commission, etc. How many engineers, if any, are there on these boards, and is it customary to appoint on boards where large engineering works are to be discussed and decided upon, any engineers as members thereon?

We have under discussion, the appointment of Water Commissioners for the management and control of irrigation works under the provisions of a bill which has just been introduced into the Montana Legislature. I have no doubt of the propriety of engineers acting on such a board, nor do I doubt that competent professional men would greatly add to the efficiency of a board rather than one composed entirely of business men.

Irrigation.

Helena, Mont., Jan. 20, 1893.

(In answer to the above we can say that Gen. James C. Duane, late Chief of Engineers, United States Army, is now a member of the Croton Aqueduct Commission, and Mr. L. E. Cooley, on the Chicago River Drainage Commission, is a graduate of an engineering school, was professor of civil engineering, has long practiced this profession, and was at one time Chief Engineer of the Commission of which he is now a member. As to the general practice in this connection, it is only too well known that "practical politics" has often much to do with the appointment of members of boards having in their charge public works involving a large expenditure of public money. In such cases the appointing powers rather discourage the employment of trained men who might watch too closely the methods of conduct found most expedient. But when the appointment is made solely in the interest of the public, and the work is of an engineering character, it is usual for at least one member of the board to be an engineer of repute and experience. As examples, we may mention that in Massachusetts, Mr. Desmond Fitzgerald, M. Am. Soc. C. E., is a member of the State Topographical Survey Commission; Mr. Hiram F. Mills, C. E., is on the State Board of Health; Prof. George F. Swain, Professor of Civil Engineering in the Massachusetts Institute of Technology, is on the State Railway Commission, and Mr. Clemens Herschel, a prominent civil engineer, was on that board before him. Mr. W. E. McClintock, M. Am. Soc. C. E., is a member of the Massachusetts Highway Commission. In New York, at least one member of the Rapid Transit Commission may claim engineering knowledge; that is Mr. Samuel Spencer, who was formerly General Manager of the Baltimore & Ohio Railway Co. Among the Brooklyn Bridge Trustees have been Messrs. Thomas C. Clarke, Charles Macdonald and Mr. George W. McNulty, all members of the American Society of Civil Engineers. This list could be much extended, but cases enough have been cited to show that in such boards the presence of at least one trained man is deemed essential in assisting the business men of the board to arrive at proper conclusions in discussing matters of an engineering nature.—Ed.)

GOOD DREDGING WORK AT BALTIMORE.

Sir: I noticed with much interest for several reasons the reference in your issue of Jan. 19, pages 55 and 56, to the improvement of the harbor of Philadelphia. One reason is that the work is in charge of one of the most competent officers of the Corps of Engineers. Another is that I once had some connection with the improvement he now has in hand.

In view of your remark as to the "stiff requirements" of his specifications, viz., the removal of about 300,000 or 350,000 cu. yds. per month from April to December, I think you will find the table below interesting, exhibiting, as it does what was actually done in the improvement of the channel to Baltimore, and showing that Major Raymond has not over-estimated what may be done by competent parties. This table was prepared by Mr. T. I. George, who was the superintendent, day by day, of the work, so successfully brought to a conclusion in December, 1892, giving Baltimore a channel 27 ft. deep at mean low water, and not less than 600 ft. wide at any point. The very capable and energetic contractor for this work was the American Dredging Co., of Philadelphia.

The ordinary individual does not realize what a lot of stuff 6¼ millions of cubic yards means. If put to him in the following way, however, he does: If this mass were piled on Pennsylvania Ave., in Washington, a very wide street, from the Capitol to the Treasury Department, it would fill the street from house to house on the sides, and be 200 ft. high, nearly half the height of the Washington monument.

The following table is a summary of dredging in the channels leading to the harbor, at Baltimore, Md., by the American Dredging Co., of Philadelphia, Pa. Commenced Feb. 17, 1891; completed Dec. 6, 1892. The figures in brackets, under Number of Dredges, indicate the number of days' work for one or more of the dredges. For instance, in February, 1891, one dredge worked 10 days and the other 9 days. In December, 1891, five dredges made full time; and of the remaining two dredges one worked 23 days and the other 21:

Month.	No. of dredges.	Cu. yds.
1891.		
Feb.	2 (9, 10)	38,805
March	2	157,951
April	5 (17, 20)	283,759
May	7 (10, 25)	398,495
June	7	455,526
July	7	490,681
Aug.	7 (7)	448,328
Sept.	8 (13)	466,703
Oct.	8	355,574
Nov.	8 (11, 17)	252,721
Dec.	7 (21, 23)	204,080
1892.		
Jan.	5 (16, 16, 20, 20, 20)	132,522
March	3 (10, 10, 10)	61,005
April	7 (17, 24, 24, 12)	339,812
May	8 (20)	408,158
June	7	340,566
July	7 (25, 15)	309,139
Aug.	6 (2)	329,663
Sept.	5 (19)	266,700
Oct.	4	228,947
Nov.	4 (23)	216,339
Dec.	2 (6, 6)	15,705
Total		6,219,179

In July, 1891, the Atlas Dredging Co.'s dredge "Dauntless" removed 140,000 cu. yds. On July 10, 1891, the Atlas Dredging Co.'s dredge "Dauntless" removed 6,879 cu. yds. in 11 hours. On July 10, 1891, there were removed by seven dredges (4 grapples, in soft material; 3 dippers, in hard material) 26,487 cu. yds. in one day. The shortest tow for the "Dauntless" was four miles. The tow varied in length from one mile to 13 miles.

Respectfully yours,

Wm. P. Craighill.

U. S. Engineer's Office, Baltimore, Md., Jan. 26, 1892.

CORROSION OF IRON IN RAILWAY BRIDGES.

Sir: In the article on "Corrosion of an Overhead Bridge by Locomotive Gases," in your issue of Jan 19, you say: "Although numerous cases are instanced where this corrosion has taken place to the extent of not only weakening iron bridges and other iron structures, but of actually making them unsafe, there is almost nothing in engineering literature treating scientifically of the chemical action which takes place, and the concomitant conditions and elements necessary to its most rapid work of corrosion."

In view of the scarcity of engineering literature upon this subject, perhaps an abstract of a contribution which I made to it as long ago as 1885,* will be of interest. It described an examination of some pieces of iron rust taken from a bridge on the Pennsylvania R. R., in order to determine if possible the cause of the rusting.

The rust was in several pieces or flat plates, some of which were as much as ⅛ in. in thickness. Some were quite friable, being easily broken by the fingers, while others required a light tap with a hammer to break them. All of the plates were covered on the outer side with a thick coating of a sooty nature, which was no doubt finally divided carbon deposited from the smoke of the locomotives. In other respects the rust was in no way distinguishable to the eye from iron rust formed in the atmosphere under ordinary circumstances. A portion of the rust was finely powdered, put into a flask, and distilled water, free from ammonia, added. The flask was tightly corked and exposed to a gentle heat for two weeks. The water was then filtered off, and examined to find whether any thing had gone into solution. It had a strongly bituminous odor, a thin oily film appeared upon the surface, and it was neutral to test paper. A careful qualitative analysis showed the presence, in the water solution, of iron, ammonia, sulphuric acid and traces of sulphurous acid and chlorine. Nitric and nitrous acids were searched for, but could not be found. A separate portion of the rust was tested for carbonic acid, and it was found in considerable quantity. The water solution was evaporated to dryness, and a small grayish residue was left.

The result of the analysis suggests at once the causes of the rapid oxidation of the iron. The presence of carbonic, sulphuric and sulphurous acids, no matter how small in quantity, is sufficient to promote rapid corrosion. The sources from which these substances are derived are evidently the escaping gases of the locomotive, which contain carbonic acid, carbonic oxide, moisture, and if there is sulphur in the coal, sulphurous and sulphuric acids. The chlorine and ammonia found may come either from the atmosphere, or from the water used in the locomotive. It would be interesting to know the action of each of the various gases above mentioned upon iron, to learn which of them has the greatest tendency to cause corrosion. The literature upon the subject is not extensive. One writer, however, Prof. F. Grace Calvert, has conclusively shown that carbonic acid is a most active agent in presence of moisture to promote corrosion. I refer to papers describing his experiments, published in the "London Chemical News," Jan. 28 and March 11, 1870, and March 3, 1871, and also to his experiments upon the action of sea water upon iron, published in the "Engineer," Aug. 25, 1865, and "Engineering," Dec. 20, 1867.

Among other interesting observations Professor Calvert remarks that Claude Berdouiln first discovered in 1683 that ammonia is formed when aerated water acts upon steel. In 1720, E. F. Geoffrey found that iron rust formed in the air contains moisture and ammonia.

With these researches of Professor Calvert before us, we have no difficulty in accounting for the rapid oxidation of iron in railway bridges. All the conditions necessary to promote corrosion are present. The carbonic acid and moisture escaping from the locomotives would themselves be sufficient; but when to this we add the sulphuric acid and chlorine, both of which were found in the analysis, we have, when they are dissolved in the moisture, an acid or a saline liquid capable of the most energetic action. Furthermore, the presence of the carbonaceous deposit has, no doubt, a tendency to assist the corrosion, both by its acting as a nucleus which retains the moisture and acids and condenses the gasses within its pores, and by its inducing galvanic action, carbon being electro-negative to iron. The reason of the presence of ammonia in iron rust is stated by Bloxam, who says that it is formed from the nitrogen in the air during the process of rusting. It appears that the water is decomposed by the iron, and the liberated hydrogen enters at once into combination with the nitrogen held in solution by the water to form ammonia.

In connection with this subject, the writer has made an experiment to determine the action of sulphurous acid upon iron, as follows: Two one-half litre flasks were taken, and in one was placed about two ounces of clean and bright wrought iron turnings, and in the other two ounces of old rusty lath nails. Ten cubic centimetres of water was added to each, enough to merely wet the iron, and a current of sulphurous acid gas was then passed into each for a few minutes, and the flasks tightly corked and sealed. The gas had an immediate and energetic action in each case. The bright turnings at once became black, and then a white sandy-like deposit appeared in the bottom of the flask. On shaking this deposit around the side of the flask, it in a few minutes changed to a grayish color, and afterward a part of it became of the color of iron rust. The lath nails in the other flask at first lost their rusty appearance, and then the white deposit appeared as in the first case. A third flask was then taken and ten cubic centimeters of water put in it, and filled with sulphurous acid gas and corked; but no iron was put in it. All three flasks were kept corked for a week, and then opened. The third flask had a suffocating odor of sulphurous acid, and the water in the bottom contained both sulphurous and sulphuric acids. The other flasks were entirely free from any smell of sulphurous acid. The water was tested and found to contain protosulphate of iron. The precipitate around the sides of the flask was dissolved in hydrochloric acid, and found to contain sulphuric acid and iron, both as ferrous and ferric oxide. The iron nails and turnings were weighed and found to have lost nearly 1% of their original weight. This experiment seems to show that sulphurous acid is rapidly changed into sulphuric acid in the presence of iron and moisture, and that the iron is thereby rapidly corroded. The sulphurous acid escaping from the locomotives must, therefore, be considered one of the most active agents of the corrosion of railway bridges.

Wm. Kent.

M. Am. Soc. M. E.

New York.

* In an article entitled, "The Rapid Corrosion of Iron in Railway Bridges," published in the "Iron Age" of May 27, 1885, and reprinted in the Journal of the Franklin Institute in June of the same year.

PERSONAL.—FRANCIS MEAGHER.

Sir: I am asked by his relatives to endeavor to learn something about a young civil engineer, Francis Meagher, of Dublin, and of a well known family, who was on the isthmus, engaged on the Panama Canal, in 1884, and from whom nothing has since been heard by his family. I am told that a gentleman of my own

Dredging Co.—and of whom I can get no trace also—would be likely to know something of the circumstances, should Mr. M. have died at that time. I shall be grateful to any reader of the News who may give me any information that may aid in obtaining definite news in relation to the young man of whom such information is most anxiously sought by his friends. Yours truly,

Ithaca, N. Y., Jan. 26, 1893. R. H. Thurston.

THE EAST RIVER BRIDGES.

Sir: Regarding the action of the Secretary of War in placing the height of new East River bridges at 140 ft., and reason existing for such action, I have been given to understand that it has been so decided because the East River channel hugs the east shore at points selected for the new bridges.

With a central height of 140 ft. there will be scarcely more than 135 ft. over the channel; and as our present bridge gives 135 ft. clearance over the channel, it would not be advisable to build a new structure with less clearance. Vessels in tow are particularly hard to manage, and on a strong tide will invariably drift into the channel of the river. This suggestion will, undoubtedly, make clear the reason for the decision referred to. Yours truly,

New York, Jan. 27, 1893. Wm. W. Crehore.

TOWNSHIP MERIDIANS.

Sir: In view of the many errors being made in surveying every day by the use of the compass, and the fact that the compass is used in rural districts, and to some extent even in cities and towns; also taking account of the fact that the magnetic variation is a quantity quite different even in towns quite near each other, what sort of an idea would it be for a state to appropriate money for the establishing of a meridian in each township, marked by permanent bounds? Then a law should be passed requiring all surveys of lands to be made with reference to the same, or with true azimuths and distances. Is the idea a practical one, or would it fail from want of support by the profession? Very truly yours,

William Nelson.

Laconia, N. H., Jan. 8.

(Such meridians are already established in different parts of the United States, though their use so far is rather limited. If surveyors were compelled to use the transit, and to make observations for true azimuth, or at any rate to use nothing less exact than the solar compass; and if it were also compulsory to file exact notes of surveys, with bearings of all lines from a true meridian, which notes must be accessible to every one, it would not be long before a survey could easily be made in any part of a township from lines of known azimuth. A number of separate observations, carefully made, would probably lead to more correct results than would be reached by carrying a meridian to any great distance east or west from a standard at the county seat, as, besides the chances of error in carrying such a line, a correction for longitude requiring some calculation would have to be made. There is a growing sense of the need of laws to regulate the working of surveys, and action has already been taken in some states. For instance, the Ohio Society of Surveyors and Engineers has a bill for this purpose now before the legislature. We believe that our correspondent's idea is quite a practical one, and that improvement in this respect will soon be made. —Ed.)

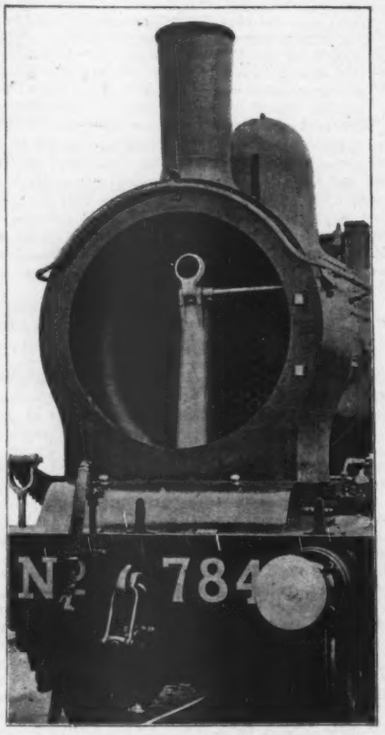
NOTES AND QUERIES.

G. A. Fowle, Alexandria, Va., asks: Can you send me the address of some manufacturer of fire escapes of the most approved plan.—As the name of such manufacturers is legion, we can do no more than make public this request.

A. T., of New York, asks for reliable information relating to electric street railways with more than 5% grades. There are a number of lines in the United States operated on steeper grades. Perhaps the most remarkable case is the San Francisco & San Mateo electric railway, which is a double-track road, with one grade at 11⅘% and another at 14%. The first named grade is operated in the usual manner, and is generally regarded as the maximum for electric service alone. The 14%-grade is only used on the down-grade trip, and is operated by a cable and counter-balance running in a conduit beneath the track. The details are briefly given in our issue of Sept. 1, 1892. As to full description of machinery, cost of maintenance, operation, etc., asked for, we can only refer our correspondent to the company itself. It is, or was then, the only electric railway in San Francisco.

AN ENGLISH VARIABLE EXHAUST NOZZLE.

We illustrate herewith a locomotive on one of the principal English railways fitted with a variable exhaust nozzle invented by Mr. Geo. Macallan, Superintendent of the Stratford shops of the Great Eastern Ry. The cut, which is reproduced from a photograph, shows the construction so clearly that little explanation is necessary. It will be seen that while this arrangement gives only two sizes of opening, it avoids the obstruction of the flow of steam by mechanism in the interior of the nozzle, and the moving parts are so simple that they are not likely to become clogged. This nozzle has been in use for over three years on some of the Great Eastern locomotives, and the total number of locomotives fitted with it in England is now over 250, this number including locomotives on several of the principal English railways. As generally used, the fixed opening in the blast pipe is made large enough to keep up steam when the engine is doing ordinary work. The opening in the movable top is made 30 to 40% smaller, and when, in ascending grades or pulling a very heavy train, the steam pressure begins to fall the movable top is turned down by a rod reaching back to the foot plate. The accompanying table gives the yearly mileage and fuel record of three locomotives on one of the principal English roads, one engine being fitted with the Macallan nozzle with 5 in. and 5⅝ in. diameter openings, and the other two fitted with plain nozzles



An English Locomotive Fitted with Macallan Variable Exhaust Nozzle.

5 ins. in diameter. All the locomotives had four wheels coupled, and were built for fast passenger service. They were identical in construction, with the exception of the exhaust nozzles, and they worked in turn the same main line passenger trains. No. 755 was turned out of the shops new on June 28, 1889, and the other two were completed Sept. 4. The results of three years' working show that the average coal consumption per train mile by the engine with the variable nozzle is 3.9 lbs. less than the average consumption of the two engines with which it is compared, which amounts to a saving in fuel of about 11% by the use of the device. While records of fuel saving through the use of special appliances on locomotives are generally considered of doubtful value, this is largely because such records are frequently made in special tests of short duration. As the figures in the accompanying table are the yearly records, they seem worthy of careful consideration.

Comparative Fuel Records of Locomotives with Variable Exhaust Nozzles and with Plain Nozzles:

Engine.	Mileage — Train.	Mileage — Engine.	Coal burned, long tons.	Average coal burned lbs. — Per ton mile.	Average coal burned lbs. — Per engine mile.
1889.—Sept. 4, to Dec. 31:					
754. Plain nozzle.....	12,302	13,225	177.5	32.4	30.1
755. Variable nozzle...	12,563	13,083	172.7	30.8	29.6
756. Plain nozzle.....	12,262	12,699	180.5	33.0	31.8
1890:					
754. Plain nozzle.....	28,272	30,311	438.7	34.7	32.4
755. Variable nozzle...	41,879	42,996	561.5	30.0	29.3
756. Plain nozzle.....	43,256	44,519	638.5	33.1	32.1
1891:					
754. Plain nozzle.....	35,346	39,106	534.6	33.9	30.6
755. Variable nozzle...	36,325	37,237	479.1	29.5	28.8
756. Plain nozzle.....	33,282	34,623	507.5	34.2	32.8
1892 (to Sept. 2):					
754. Plain nozzle.....	21,502	22,531	343.8	35.7	34.2
755. Variable nozzle...	24,703	25,359	339.0	30.7	29.9
756. Plain nozzle.....	28,530	29,762	460.8	36.2	34.7
Total:					
754. Plain nozzle.....	97,512	105,173	1,494.4	34.3	31.8
755. Variable nozzle...	115,475	118,675	1,552.3	30.1	29.3
756. Plain nozzle.....	117,330	121,603	1,787.4	34.1	32.9

The American patent on this device is No. 453,321, issued to Charles Adams and George Macallan, dated June 2, 1891. The claims of the patent are as follows:

1. The combination of a blast-pipe, a movable cap, which when in place rests on the top of the blast-pipe, and a liner inside both the cap and the mouth of the blast-pipe and covering the joint.
2. The combination of a blast-pipe, a movable cap hinged to the blast-pipe and which when in place rests on the top edge of the pipe, and a liner inside both the cap and the pipe and covering the joint between them.
3. The combination of a blast-pipe, the lugs thereon, the spindle mounted in bearings in the lugs, the annular cap provided with an arm connected to the spindle and arranged between the lugs, and a liner inside both the cap and the pipe, and covering the joint between them.

It will be noted that the liner, which is apparently not an essential part of the device, is included in each of the above claims. This would indicate that the general principle embodied in this device has been already covered by previous patents. It would certainly be strange, in view of the great multitude of variable exhaust devices that are on the patent records, if this simple method of varying the nozzle opening had been wholly neglected until now.

A FRENCH MAGNETIC TOWING DEVICE.

At the late French Congress on Internal Navigation, Messrs. Molinos and Bovet, in a letter to the manager of the Towing Co. of the Lower Seine and the Oise, described a proposed system of river towage by magnetic adherence. The system is to be applied to the navigable rivers of France, and it is to supplement and make more economical the present system of towing by hauling on a continuous chain lying on the bottom of the river.

The inventors propose to do away with the numerous turns of the chain around the towing drums and the inherent difficulties from slack, etc., and to obtain a sufficient adherence of the chain to the towing pulley by a three-quarter turn of the chain. To do this they convert the drum or pulley into a magnet. This pulley (Fig. 1) is made of two flanges of cast steel, adjusted with care and connected by bronze bolts. Between the flanges is an annular cavity partially filled by a winding of conducting wires, protected from water, etc., by a bronze cap. The electric current is led to the axis of the pulley shaft by two insulated rings connected with the coil of wire. The flanges of soft steel thus make up the poles of an electro-magnet of great power; and the chain which works in the groove of this magnet-pulley unites the poles for the time in a short circuit. To obtain the maximum useful effect it is necessary to employ a considerable mass of steel and to reduce to a minimum the play of the chain in the groove. As the weight and size of the chain diminish rapidly in use, it is evident that the adherence will vary with the state of the chain and with different parts of the route. But as the best and strongest chain is always where the most considerable effort is demanded, this fact presents little real difficulty. Tests have been made with a new chain weighing 16 kg. per metre, and the same chain worn until it weighed only 9 kg. per metre.

The pulley was mounted upon a gallows-frame for the purpose of experiment and wedged to prevent turning (Fig. 3). Weights to represent the load and operated by means of a rolling bridge were suspended at one end of the chain, the other end hanging free, as at A B. When it was desired to obtain the three-quarters turn of the chain required for a definite attachment to the boat, the chain was passed by hand to the position C D, and after the current was turned on the bridge was maneuvred so as to have the weight bear upon the chain.

In seeking the intensity of current necessary to obtain the greatest possible adherence, experiment was made with a new chain, and the maximum magnetization of the chain was forced with a medium current. Two links or circuits were arranged as shown in Fig. 4, and the current was varied progressively until an augmentation of intensity gave no new augmentation of adherence. It was then concluded that the point of saturation had been reached. This result was obtained with about 37,000 ampere turns, which for 20 rows of the 27 spiral turns of the pulley correspond to 48 amperes. The electro-motive force was 70 volts, and the work done was equivalent to 4½ HP.

By employing a current of this character it was proven that with a three-quarter turn of the chain around the pulley a load of 13,000 to 19,500 lbs. was sustained. But the saturation of this chain

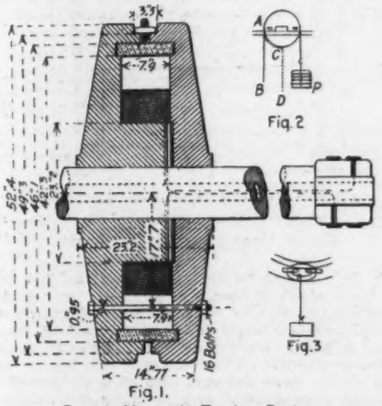


Fig.1.

French Magnetic Towing Device.

was obtained with a much less current, and the same weight was sustained with only 23,000 ampere turns. With the gallows frame used in these experiments, it was not possible to determine the limit of weight that a new chain would carry under similar conditions; but it was estimated that 22,000 lbs. could be supported. On the other hand the towing tension between the towing boat and its train of boats, according to experiments made by the company, does not exceed 9,500 lbs. Upon the chain this tension is augmented by the resistance proper of the towing boat; but the figure of 13,600 lbs. can be taken as the maximum of effort expended in the most difficult parts of the river course.

Upon the tow in motion several causes operate to diminish the adherence on the pulley. These are the shocks experienced by the towing boat or the boats towed, the water which wets the chain, the little leeches that come up from the bottom on the chain and are crushed on the drums, forming a slimy coating, and finally the twisting of the chain, which cannot be entirely stopped. These experiments proved that the shocks had little influence, the chain adjusting itself by short successive displacements, with no general slip. As to the second cause, experiments were made with a chain wet with water and with soap-suds, and the loss of adherence, in the two cases, was about 10%. One end of the chain was then twisted by hand over a length of 2m., the chain making a complete half-turn upon its axis. The result was that part of the chain still entered the small groove in the pulley, and acted even more forcibly upon the outer groove. The chain thus arranged, or disarranged, supported a weight of 14,740 lbs. With the chain still twisted, and both the pulley and the chain well greased, a load of 8,800 lbs. was supported.

As a result of these experiments a towing boat is being built at Lyons, fitted with a screw and with the magnetized drum. The compound engine on this craft, with cylinders of 25⅝ and 14 3-16 in. and 15¾-in. stroke will develop 150 HP. when applied to the screw with 150 revolutions, or when used for chain-hauling it will develop 60 to 80 HP. with 90 turns upon the chain and 20 turns upon the towing pulley. The electric apparatus can be shut up in a case, 4×4×2.6 ft., and includes a 3 to 5 HP. dynamo making about 1,000 revs. Projecting from this box is the magnetized pulley and a controlling handle. The apparatus weighs about 3,300 lbs. In testing this boat two chains weighing 27.1 lbs. per ft. will be laid on the bottom of the canal, one near each bank, so as to avoid interference by boats passing in opposite directions.

It should be mentioned in this connection that the usual practice in France is to provide a towing boat, which hauls a train of loaded boats. In ascending the river the hauling is done by means of a submerged chain lying on the bottom of the river. This chain passes over the bow of the towing boat on an adjustable pulley, usually passes around what are called towing-drums, operated by an engine, and then leaves the boat over another pulley at the rear end. These boats are often provided with a screw-propeller, operated by the same engine that works the chain-drums and used in descending the river. The power to operate the dynamo, called for in the device of Mr. Bovet, is thus already aboard the towboat. In using the present system of hauling, the grooves in the drum are unequal, and an abnormal tension is put upon the chain, resulting in frequent ruptures. The length of the chain rolled upon the drums varies from 100 to 160 ft.; and to avoid the general displacement of the chain on the bottom of the river by reason of this slack, boats are obliged to pass down as well as up the river by the chain. This practice necessitates a system of relays, exchange of tows, and a maintenance of relative position in the general chain of tows. The loss of time resulting is rapidly augmented with the number of boats in service. Mr. Bovet proposes to decrease this loss of time and generally to improve the conditions of service.

WHEEL FLANGES.*

By Godfrey W. Rhodes, Supt. of Motive Power, C., B. & Q. R. R.

Many practical railroad men, as well as those not versed in railroad matters, often consider with wonder and astonishment the work which mechanics intrust to and expect the wheel flange to perform, and good cause is there to pause and examine this feature of our rolling stock, for in our entire equipment there is not a more simple or more effectual design constructed, when we weigh the importance of the work performed. On the strength of this small 1⅛×1½-in. protection on the inside of steel tired and cast iron wheels depends the safety of the thousands of trains that are speeding over the railroads of this country in all directions at the present moment. Regardless of speed, regardless of curves and grades, on the strength of this flange, to a great extent, rests the practicability of maintaining trains on the metals.

When, however, we consider frogs, crossovers and guard rails an entirely different aspect of the question presents itself, viz., the relation of the wheel flange as located on the axle to the gage of the track. In these days of high speeds, when the practicability of traveling at 100 miles an hour is not only freely discussed, but sought after, there is no more important work to look after than the gage of flanges in their relation to the track.

The shape of the flanges has been exhaustively discussed by both the Master Mechanics' and the Master Car Builders' associations, and standards have been adopted by them. There is little, if any, room for criticism of these designs, and it is not our intention to discuss their merits or demerits. It is sufficient to say they have been adopted by the associations as their standards, and have well stood the test of service.

This afternoon we propose to invite your attention chiefly to some points illustrating how a careless adherence to the above standards may bring about very serious and dangerous results when we consider the question of flange in its relation to wheel gage and track gage.

The standard distance between the backs of flanges of car wheels is 4 ft. 5⅜ ins.

At the 1885 Convention of the M. C. B. Association, a committee recommended (see p. 16 of report) that in fitting wheels on axles a variation be allowed of ⅛ in. each way from the standard distance of 4 ft. 5⅜ ins. between flanges, making the maximum distance 4 ft. 5½ ins., and the minimum 4 ft. 5¼ ins. This was adopted by the association, and is now its standard for mounting wheels.

It was not, however, until the following year, 1886, that wheel gage limits were introduced into the M. C. B. rules of interchange, and the present wider limits adopted for wheels in service, which are 4 ft.

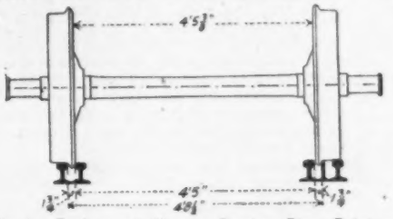


Fig. 1. Position of Wheels Passing Frog Point on Track of 4 Ft. 8½ Ins. Gage.

5 ins. for the minimum distance and 4 ft. 5¾ ins. for the maximum. This is rather remarkable when we consider the important part that the wheel gage plays in the safety of running cars. Moreover, it was not a new idea; various lines had for years previous to this adopted limits for the distances between and over flanges. Perhaps the real reason for so long evading the question in the rules was the difficulty in reconciling the interests of the roads using a 4 ft. 8½-in. gage, and those using 4 ft. 9 ins. As the standard wheel gage for 4 ft. 9-in. track and 4 ft. 8½-in. track must necessarily be different,

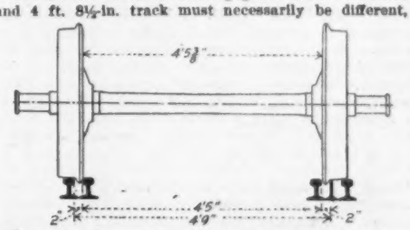


Fig. 2. Position of Wheels Passing Frog Point on Track of 4 Ft. 9 Ins. Gage.

let us consider how it was possible for these two interests to adopt the same limits. First of all let us understand thoroughly why 4 ft. 5 ins. is the minimum limit. Simply because 4 ft. 5 ins. is the distance between the guard rail and wing of frog, both for 4 ft. 8½-in. track and 4 ft. 9-in. track. In the former case, by having 1¾ ins. space between gage and guard rail, and also between the frog point and wing of frog, and in the latter case by having 2 ins. at the same points (see Figs. 1 and 2), the problem was solved. But any wheels measuring less than 4 ft. 5 ins. between flanges would have a tendency to either mount the guard rail, or by crowding their way through to bring stresses likely to produce broken axles.

Let us next consider the reasons which make a maximum limit for the distance between flanges important. Referring to Fig. 3 we find the dimensions of wheels and track comparing as follows:

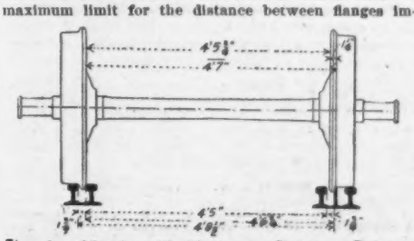


Fig. 3. Wheels with Maximum Distance Between Flanges Striking a Frog Point on Track of 4 Ft 8½ Ins Gage.

Wheels, maximum between flanges	4 ft.	5⅜ ins.
" thickness of flange, (M. C. B.. std.).		1¼ "
Total.	4 "	7 "
Track, 4 ft. standard gage.		
Distance from guard rail to wing of frog.	4 ft..	5 ins.
Distance between wing of frog and frog point.		1¾ "
Total.	4 "	6¾ "
Difference, ¼ in.		

This, you will observe, is not in keeping with good practice, for it allows a wheel mounted to the maximum limit to strike a frog point on 4 ft. 8½-in. track with a full ¼-in. of wheel and clearly explains why frog points are so difficult to maintain even on 4 ft. 9-in. track. The maximum limit of 4 ft. 5½ ins., as originally

*A paper read at the January Meeting of the Western Railway Club.

adopted in 1886, was more in keeping with the usually well considered actions of the Association. The change to 4 ft. 5⅜ ins. was made in 1887. Those allowing this to go through either did not understand the importance of the matter or were considering the interests of the roads using 4 ft. 8½-in. gage. If we mount wheels beyond a 4 ft. 5½-in. limit, the wheel will come with full force against the frog point, not only ruining the point, but if the guard rail is loose and out of position, or if 4 ft. 5½ ins. is exceeded, there is a strong probability of the wheels taking the wrong side of the frog point and ditching the train. If the real cause of the many derailments that occur at switches could be carefully looked into, we will venture to say there would be but little mystery surrounding the immediate cause of such accidents. Unfortunately not only is the track broken up and distorted, but the wheels and axles are also, and the importance of clearing away and opening up the line is such that usually the real cause of such accidents remains shrouded in mystery.

Let us now consider how this question may be affected by a varying section of wheel. It should be

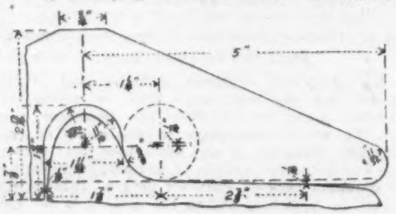


Fig. 4. Wheel Flange Gage.

borne in mind that the M. C. B. Association has no maximum flange gage, although they do have a minimum. In purchasing cast iron wheels we have at times found such variations in the thickness of flanges, even when the patterns are all identical with that used on the C., B. & Q. R. R., that we have found it necessary to adopt a maximum as well as a minimum flange gage for new wheels. The maximum gage has a 1 11-32-in. opening, and the minimum gage a 1 5-32-in. opening. Wheels with flanges thicker or thinner than these limits are rejected. The use of these gages makes it practical in mounting wheels to use a wheel gage of the form shown in Fig. 4, which controls the standard M. C. B. limit between flanges of 4 ft. 5¼ ins., and has a flange contour corresponding with our maximum flange. It prevents the acceptance of any thick flanges should our foundry wheel inspectors accept wheels which they should not.

Few railroads, we believe, use either maximum or minimum flange gages in inspecting new wheels. At a foundry in this immediate neighborhood we recently found wheels being cast and accepted for service with a flange section which exceeds even the C., B. & Q. maximum limit, being 1½ ins. thick at the throat of the wheel. Foundries do not always appreciate these differences in railroad practice.

Let us consider why with the prevailing practice of mounting wheels there should be uniformity in the thickness of flanges. The M. C. B. standard is usually estimated as measuring 1¼ ins. through the flange (some would call it 1⅛ ins.). With the same method of reckoning the flange just referred to, measures a strong 1⅜ ins. (some would say 1½ ins.). The M. C. B. wheel mounted to the maximum standard allowable between flanges measures as follows over flanges:

Distance between flanges	4 ft. 5½ ins.
Width of one flange	1⅜ "
Width of one flange	1⅜ "
Distance over flanges	4 ft. 8 ins.

The above allows ½-in. play on a 4 ft. 8½-in. track. With the 1⅜-in. flange we would have:

Distance between flanges	4 ft. 5½ ins.
Width of one flange	1⅝ "
Width of one flange	1⅝ "
Distance over flanges	4 ft. 8¼ ins.

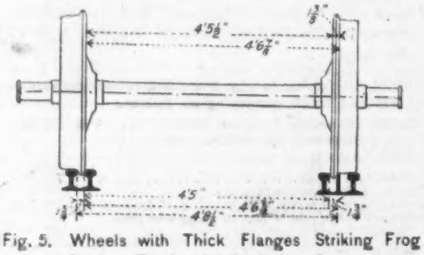


Fig. 5. Wheels with Thick Flanges Striking Frog Point on Tracks of 4 Ft. 8½ Ins. Gage.

This only allows ¼-in. side play on a 4 ft. 8½-in. track, or ⅛-in. on a side. If, however, one chooses to call the thickness of the flange 1½ ins., in place of 1⅜ ins., it is apparent that there would be no side play at all on a 4 ft. 8½-in. track.

Let us now consider how such a flange will act on the frog points of 4 ft. 8½-in. track (see Fig. 5).

Distance between wheel flanges	4 ft. 5½ ins.
Width of flange	1⅜ "
	4 ft. 6⅞ ins.
Guard rail and wing of frog	4 ft. 5 ins.
Wing of frog and frog point	1¾ ins.
	4 ft. 6¾ ins.
Difference	⅛ in.

The flange, therefore, would not clear the frog points by ⅛ in., or by ¼ in., if the flange in question is rated as measuring 1½ ins. Suppose, however, that no exception is taken to thick flanges, and that we attempt to mount them to the standard width over flanges:

Standard distance between flanges	4 ft. 5⅜ ins.
Standard thickness of flange	1¼ "
Standard thickness of flange	1¼ "
Present standard over flanges	4 ft. 7⅛ ins.
Width of thick flange	1⅝ ins.
Width of thick flange	1⅝ ins.
Necessitating a change in standard between flanges to	4 ft. 5⅛ ins.
Present standard over flanges	4 ft. 7⅛ ins.

This leaves but 4 ft. 5⅛ ins. between flanges, whereas the standard minimum limit is 4 ft. 5¼ ins. If, however, we consider our thick flange as measuring 1½ ins., we, in the same manner, will get for distance between flanges 4 ft. 4⅞ ins.:

If we wish to preserve, 4 ft. 7⅛ ins. over flanges:

Width of flange	1½ ins.
Width of flange	1½ ins.
Distance between flanges	4 ft. 4⅞ ins.
Distance over flanges	4 ft. 7⅛ ins.

There is, however, still another phase of this question to consider: what has been said is based on the assumption that wheels are accurately mounted within the M. C. B. standards. It is well known, however, that in practice, accuracy is not always followed; the interchange rules provide that cars must be accepted if the wheels do not measure more than 4 ft. 5⅝ ins. or less than 4 ft. 5 ins. between flanges—with these figures we get the results with thick flanges which are shown in Fig. 6. Thus it is possible to have wheels mounted within the gage limits of the M. C. B. interchange rules, and still not have them clear the frog points of 4 ft. 8½-in. track by ⅜ in., if we rate flanges at 1⅜ ins. thick, and ½ in., if we call them 1½ ins. In the case of 4 ft. 9-in. track, they would just clear the point with 1⅜-in. flange, and strike it with ⅛ in. of wheel, if rated as a 1½-in. flange.

It would therefore seem that the thickness of wheel

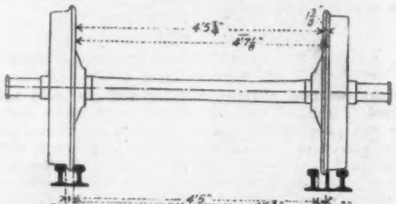


Fig. 6. Wheels with Thick Flanges and Maximum Width of Mounting.

Track:	
Distance between guard rail and wing of frog	4 ft. 5 ins.
Width of throat of frog	1¾ "
Total	4 ft. 6¾ ins.
Wheel:	
Distance between flanges	4 ft. 5⅜ ins.
Thickness of flange	1⅜ "
Total	4 ft. 7⅛ ins.
Difference	⅛ ins.

flanges plays an exceedingly important part in the consideration of this question. With the present limits between flanges, as prescribed by interchange rules, and with no limits whatever for a maximum thickness of flange, a very dangerous and expensive element is quietly being introduced under the rolling stock throughout this country. It is our opinion that a maximum flange gage should be considered at once by the association, and in adopting the same, full consideration should be given to the present wheel gage limits. There is hardly a month passes on any of the through trunk lines that we do not hear of cars mysteriously leaving the rails. Is it to be wondered at with flanges and gage limits as outlined in this paper?

In Mr. R. H. Soule's admirable collation of M. C. B. standards, presented at the last M. C. B. annual convention, he makes the rather surprising statement that the guard rail gages of the Association are but little used.

There is nothing more important on a railway than track and wheel gages, together with a thorough understanding of the relation one bears to the other. A practical illustration of failure in this respect will perhaps add force to this statement. On an important joint track in Chicago, which is run over principally by passenger trains, a series of derailments took place last fall to through passenger trains, at a frog point located on a 13° curve. The first derailment occurred on Nov. 22; the second on Nov. 30, and the third on Dec. 3.

As the speed was slow, nothing more serious than a blockade of tracks and delay of trains followed. Fully two weeks passed by before the cause of the derailment was discovered and remedied. An examination of the track finally revealed the inexcusable state of affairs represented in Fig. 7. The track foreman had evidently been endeavoring to save the wear on his frog points without considering any other phase of the question. It will be noticed that the distance between guard rail and wing of frog is actually 4 ft. 5⅜ ins.

It will be thus seen that on the assumption that the wheels were gaged strictly to the M. C. B. standard of 4 ft. 5⅜ ins. between flanges they would not clear the wing of frog by ⅝-in. even on the supposition that the flanges conformed to the M. C. B. standard. If, however, the wheels were gaged only to the interchange rule minimum limit of 4 ft. 5 ins. they could not clear such a condition of track by ¾-in. It seems almost incredible that such a condition of things could exist on a first-class railroad. The facts are nevertheless exactly as stated.

In conclusion, then, for purposes of greater safety to our present high-speed passenger and freight trains we urge renewed interest in the matter of adherence to M. C. B. standards in wheel gages, track gages and wheel flanges. We also recommend for consideration the changing of the maximum limit between flanges from 4 ft. 5⅜ ins. to that first adopted in 1886, viz.,

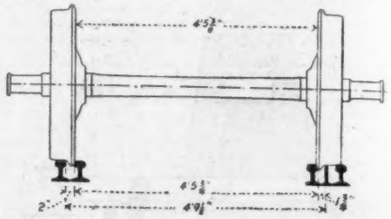


Fig. 7. Position of Guard Rail and Frog Point which Caused Three Successive Derailments.

4 ft. 5½ ins., and further, that a maximum limit for thickness of wheel flanges be adopted. By far the most effectual way of bringing about uniformity and safety, however, would be to have a uniform track gage. It is very unfortunate that this country should have two standards, 4 ft. 9 ins. and 4 ft. 8½ ins. So long as this exists and cars adapted to the narrower gage are allowed to run over the wider gage and vice versa, each line in fixing its standards must consider the dual conditions that are sure to arise. The subject of uniform track gage would seem to be one well worthy of consideration by the American Railway Association. This Association has already done much effectual work in the way of bringing about uniformity in matters which necessarily can only be made effective by action of the managers of our different railroads.

Discussion.—Mr. Barr pointed out that there was danger to the frog points from too thin flanges as well as from the causes cited above. A wheel with thin flange hugs the rail, and the wheel on the opposite end of the axle may be drawn so far to one side that its flange will strike the frog point. Probably flanges are made of extra thickness with the idea that they will wear longer; but the tread will probably be worn thin before the flange, and the wheel will be quite likely to break. Another objection to thick flanges is that they leave too little play between the rail and the flange, and the tread of the wheel will wear in a narrow groove. Mr. Cloud called attention to the general adoption of rails with vertical sides, and said this made the limiting of the flange thickness still more necessary.

RADIUS OF GYRATION OF HOLLOW, ROUND AND SQUARE COLUMNS.

By Benj. F. La Rue.

The values per unit of area of hollow, round and square columns are usually expressed by formulas which give certain unit values modified by terms of the length divided by the diameter. Such formulas give the same value per unit of area for all columns having the same ratio of length to diameter, regardless of the thickness of the metal, which is conceded to exert considerable influence upon the actual unit value.

The length divided by the least radius of gyration is now quite universally accepted to be the proper expression upon which to base a formula for finding the value (per unit of area) of metal columns. The writer gives below a short

graphical method for finding the radius of gyration of hollow, cylindrical and rectangular columns, which is correct in theory and may be of interest.

For cylindrical columns:

Lay off to a scale of 4 (or 40) a right-angled triangle, in which the base equals the outer diameter, and the altitude equals the inner diameter of the column, or vice versa. The hypothenuse, measured to a scale of unity (or 10), will be the radius of gyration sought.

These scales, 40 and 10, are usually convenient in an engineer's office, as they are always given on the ordinary triangular engineer's scale; but if they are not conveniently at hand, lay off the triangle with any scale, measure the hypothenuse with the same scale and divide by 4.

This depends upon the well known formula:

$$G = \sqrt{\frac{\text{Mom. of Inertia}}{\text{Area}}} = \sqrt{\frac{A\,D^2 - ad^2}{16}} + A - a \qquad \frac{\sqrt{D^2 + d^2}}{4},$$

in which A = area and D = diameter of outer circle, a = area and d = diameter of inner circle, and G = radius of gyration. $\sqrt{D^2 + d^2}$ becomes the expression for the hypothenuse of a right-angled triangle in which D and d are the base and altitude.

The sectional area of a hollow round column is $\pi (R^2 - r^2)$ or $.7854 (D^2 - d^2)$. By constructing a right-angled triangle in which D equals the hypothenuse and d equals the altitude, the base will equal $\sqrt{D^2 - d^2}$. Calling the value of this expression for the base B, the area will equal $.7854\ B^2$.

Value of G for square columns:

Lay off as before, but using a scale of 10, a right-angled triangle of which the base equals D or the side of the outer square, and the altidude equals d, the side of the inner square. With a scale of 3 (a scale of 30 is conveniently substituted) measure the hypothenuse, which will be, approximately the radius of gyration.

This process for square columns gives an excess of slightly more than 4%, which error is not very alarming. By deducting 4% from the result thus obtained, an approximation sufficiently close for the most refined practice will be obtained.

A very close result is also obtained by measuring the hypothenuse with the same scale by which the base and altitude were laid off, and multiplying by the decimal 0.29; more exactly, the decimal is 0.28867.

The formula is:

$$G = \sqrt{\frac{\text{Mom. of Inertia}}{\text{Area}}} = \sqrt{\frac{A\,D^2 - ad^2}{12}} + A - \qquad = \sqrt{\frac{D^2 + d^2}{12}} = \frac{1}{\sqrt{12}} \times \sqrt{D^2 + d^2},$$

but $\frac{1}{\sqrt{12}} = 0.2887$; and to write $G = 0.3\sqrt{D^2 + d^2}$ is sufficiently close for most practical purposes.

This may also be applied to any rectangular column by using the lesser diameters of an unsupported column, and the greater diameters if the column is supported in the direction of its least dimensions.

It may be well to add that as hollow rectangular columns are generally of cast iron, and as the strength of that material varies exceedingly, it is useless to attempt to be very refined in the calculations of such columns. It is scarcely worth while to use the radius of gyration for cast iron columns.

The writer once attempted to make an improved formula for cast iron columns by using the radius of gyration, but the available records of experiments showed results so varying that the attempt was abandoned. But to those who may prefer to use the radius of gyration for cast iron columns, the writer would suggest, for hollow, round or square columns, with square bearings, the formula:

$$\frac{80{,}000}{1 + .02\left(\frac{L}{r}\right)^2},$$

in which L = length in feet, and r = radius of gyration in inches.

This formula gives the same value for hollow round columns of 6 ins. outside diameter and ⅝ in. thickness of metal as the well known formula from Gordon $\frac{80{,}000}{1 + \frac{l^2}{800d^2}}$, and is perhaps as good a formula for hollow round and square cast iron columns with square bearings as can, with our present knowledge of this unreliable material, be used.

It may be well to here notice, incidentally, that in the foregoing is suggested a convenient manner in which round and square columns may be compared or equated.

This is best shown by an example:

Having a hollow cylindrical column of 8 ins. outside diameter and ½ in. thickness of metal, to find the dimensions of a square column which will be equivalent both in amount of material and in strength, i. e., in which the area of section and radius of gyration will be equal to those of the round column:

Let x represent the outer dimension and y the inner dimension of the square column; then as the radii are equal,

$$.28867\sqrt{x^2 + y^2} = .25\sqrt{64 + 49}$$

$$x^2 + y^2 = 84.746. \qquad (a)$$

As the areas are equal,

$$x^2 - y^2 = .7854\ (64 + 49) = 11.781. \qquad (b)$$

Adding (a) and (b) we find

$$x = 6.947.$$

Subtracting (b) from (a) we find

$$y = 6.04.$$

For a convenient proof,

$$x^2 - y^2 = 48.263 - 36.482 = 11.781, \text{ as in (b).}$$

THE MACDONALD SUBWAY ELECTRICAL CONDUIT.

There is a growing tendency in the large cities to require the poles and electric wires which disfigure the streets to be removed, and the wires laid in subways or conduits. We illustrate this week the Macdonald conduit of creosoted yellow pine manufactured by Eppinger & Russell, at their creosoting (dead oil of coal tar) works at Long Island City, N. Y., and the accompanying cuts show two forms of construction. The conduit is in horizontal sections, with the joints grooved and tongued (Fig. 1), or grooved and fitted with loose tongues (Fig. 2). The ducts may be square or round, and from ½ in. to 3 ins. or more in diameter, 2½ ins. being the general size. The tongues of the longitudinal joints prevent the entrance of water, and the wood itself is waterproof and very durable.

In construction only a small trench is required, and the ducts can readily be cleared out before the next section is laid. The electric cables can also be laid in place and inspected during the inspection of the subway, if desired. The conduit with nine 2½-in. ducts, contains 11.50 ft. B. M. of timber per lin. ft. or 60,720 ft. per mile, to which is to be

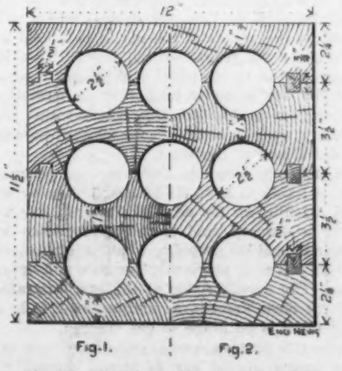


Fig. 1. Fig. 2.

Macdonald Subway Electrical Conduit.

added about 5% for wastage. The bottom of the trench being graded, the bottom section is laid, and its end joints squared (or mitered for curves); a small quantity of heated pitch, softened with dead oil so as to render it limpid and prevent it from setting too quickly, is applied to the ends and to the groove for the loose tongue. The tongue is then driven into place, and the next section laid, breaking joint with the bottom section, and firmly nailed to it. The end joints are made with a layer of cotton, and well filled with liquid pitch. The sections are secured by wire nails driven through the sides of the grooves into the tongues, and the top section is put on with screws so that it can be removed and other intermediate sections laid to increase the capacity of the subway. A creosoted plank is laid on top of the subway to prevent damage by future excavation. The subway can be cut and sealed at any point for making repairs to the cables. The wood has proved very durable, being in good condition after five years' service. The New York & New Jersey Telephone Co. has about five miles of the Macdonald conduit and 55 miles of single duct conduit of creosoted wood made by the company. It is also used for electric light and telephone service in Philadelphia, Pa.; Paterson, N. J.; Buffalo, N. Y., and Montreal, Canada.

THE GROWTH OF PATENT ISSUES IN THE UNITED STATES.

The last report of the United States Commissioner of Patents contains several graphic exhibits of the growth in numbers of patents issued to citizens of the United States in the century ending 1890, and a study of these diagrams leads to some interesting deductions. The first law controlling the issue of patents in the United States was passed by Congress in 1790; though at that time about 1,700 patents or caveats had already been granted under previous crude enactments by local or state authority.

The development of the inventive faculties of Americans seems to have been very slow in the earlier years of our national existence, if the issue of patents is to be taken as a basis of estimate. With the population increasing in a steady but rapid upward curve, the issue of patents, as recorded on the chart, shows a very slow growth until after the middle of the present century was passed. The passage of the new patent laws of 1836 and 1870 showed a depressing rather than an encouraging effect upon the efforts of inventors.

The year 1852 is the first point of marked departure in this respect, and the rate of issue increased from 1,020 patents issued in that year to 4,819 issues in 1860. The effect of the Civil War was at first to decrease the number of applications; but the urgent call for new devices of all kinds, brought out by the war itself, soon overcame this slight depression, as is shown by the fact that in the interval 1862-67, through which period the war may be said to have still influenced inventors, the issues rose in numbers from 3,521 to 13,015. After 1867 the rate of yearly growth was steady and rapid, with some falling off in 1871, 1872 and 1879. In the year 1891 there were 40,552 applications; 2,408 caveats were filed and 23,244 patents were issued.

The next chart shows the number of patents issued to individual states in the period 1790-1890, and per 1,000 of state population annually. Up to about 1850 this ratio per 1,000 was low, and in this respect the several groups of states did not differ widely, the highest ratio being less than 1 per 1,000. But the rapid increase in manufactures and the founding of great industries in the Eastern, Middle and Western States after that date caused a very marked growth in the ratio of patents granted, as contrasted with the agricultural states of the South and West. The wits of inventors were sharpened by the demands of surrounding conditions in the industrial communities; and Connecticut, famed for the introduction of basswood hams and wooden nutmegs in our earlier annals, maintains her supremacy for inventive genius throughout the century, with the highest ratio given, that of 13.1 patents yearly for 1,000 of population.

As to the South, the list of patents granted annually shows that conditions are now rapidly changing, and the marked development of Southern industries indicates a corresponding encouragement to inventors. Alabama, for example, took out 103 patents in 1890, as contrasted with 62 in 1880 and 36 in 1870. Georgia, Louisiana and South and North Carolina show a similar late increase in issues, while Mississippi, Florida and Arkansas remain at about the same low ratio for years. Taken as states, regardless of population, New York comes first, with 101,989 patents granted in the period 1790-1890; Pennsylvania comes next, with 51,140; then Massachusetts, with 48,992; Ohio,

34,606; Illinois, 33,642; and Connecticut, with 21,810 patents.

But the benefits of the patent system are by no means confined to the manufacturing industries. As the Commissioner of Patents points out in his report, it was the invention of the schoolmaster Whitney, in his improvement of the cotton gin, that made possible the marvelous cotton culture of the South; and the settlement, cultivation and growth of the Great West are due to patented improvements in agriculture and in transportation. Under previously existing conditions it would have required the labor of about 24,000,000 men and boys to plant, till and harvest the American corn crop of 1889, a laboring force considerably outnumbering the entire population of the United States in 1850. This corn crop was over 2,000,000,000 bushels raised on 78,000,000 acres of land; and the above estimate of labor required takes no account of the 490,000,000 bushels of wheat and 750,000,000 bushels of oats produced in that same year. Without present transportation facilities each bushel of this grain would have consumed its total value in a carriage of 300 miles; whereas it is now taken across a continent, shipped across the Atlantic and still sold at some profit.

A discussion of the patent system and its history, accompanied by a diagram on a larger scale, was published in our issue of April 18, 1891.

SAPLESS CEDAR BLOCK PAVING.

In a paper recently read before the Western Society of Engineers and printed in the Journal of the Association of Engineering Societies, Mr. Thomas Appleton gives a brief account of the manufacture and durability of the "sapless" cedar block paving, or, in plainer terms, a pavement of cedar blocks from which the sap wood has been removed, now in use in the town of East Saginaw, Mich. Prior to 1886 the cedar paving blocks used were sawed from peeled cedar fence posts, the bark and knots only being removed. On most of the streets of the town the travel was not heavy enough to wear out this pavement before it perished by decay. This decay naturally took place soonest in the sap wood, which, being softer than the heart wood, broomed up and wore away, leaving a rounded top surface to the block, and making a very rough pavement in a few years. It was therefore decided to try a cedar paving block with the sapwood removed. The first of this was laid in 1886, and since that time no other kind has been used. An examination of the sapless block paving laid in 1886, made in October, 1892, showed that the blocks were sound on all sides, and that there had been very little brooming. Details of the manufacture and cost of these sapless cedar blocks are given as follows by Mr. Appleton:

In manufacturing the sapless block, the cedar is first sawed into block lengths. It is not necessary to remove the bark, as it comes off with the sap wood. The blocks are then taken to a press or punching machine. The bed of this machine has holes four, five, six, seven, eight, nine and ten inches in diameter. At the top of these holes circular collars or knives are secured standing up two or three inches above the bed plate. A block is placed on one of these knives, and the platen descending forces the block down through the hole in the bed, while the sap wood and bark is shaved off above the bed. The intention is to take off all the sap and no more, so that the attendant places the block over the largest die that he thinks the heart wood will fill. In case he misjudges the size of the heart wood, and the resulting block still has some sap wood upon it, the block can be punched again through the next smaller sized die and the sap wood entirely removed. Generally, the defective blocks as they come from the punching press are taken to a second machine, which has one straight knife and other knives of various radii of curvature, and these hole in the bed, while the sapwood and bark is any decayed wood that may be on one side of the block.

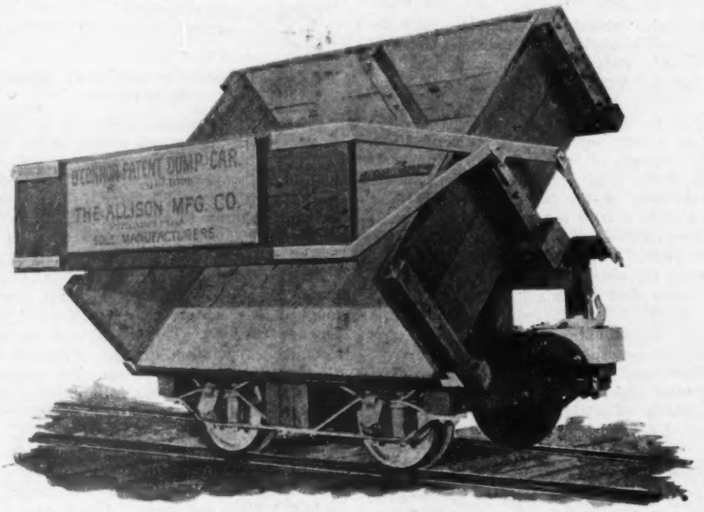
The block from the punching press has a very pretty appearance. Each block is a perfect cylinder, with sides straight and true. No knots or bunches are left, so that they can be set close together in paving. Those that have passed through the second machine have equally straight sides, but their cross-section is not always a true circle; it may be a segment of a circle with a straight side. But there are plenty of places for split blocks, and as long as the blocks are sound and free from sap, it is not essential that they should all be exactly cylindrical.

The common cedar block is made only from small sized trees, of such size as would be used for fence posts. The sapless block is made from any size of tree, large or small, solid or hollow hearted. Any piece that has 4 ins. of good heart wood goes into paving blocks, but the wood is all heart wood, and of good, sound timber.

The average cedar block has from 25% to 35% sap wood upon it. Sap ¾ in. thick on a 7-in. block would make 24% sap wood. On a 4-in. block the same thickness of sap would make 34% of the entire area of the block. On some blocks the sap will run more than ¾ in. in thickness. Throwing away 34% of the material adds to the cost of the paving. A pertinent inquiry is, what does this sapless cedar block cost? On the first piece of cedar block paving in East Saginaw, the extra cost for sapless blocks was 10 cts. per sq. yd. over the cost of common blocks. Recent figures for sapless block paving in some of our suburbs give a difference of 30 cts. per sq. yd. I understand that this latter difference is largely due to the cost of railway freight from the block manufactory in Michigan. If the blocks were manufactured in this city just as the common blocks are, this difference of 30 cts. per sq. yd. would probably be reduced.

A NEW DUMP CAR.

We illustrate herewith a novel style of dump car, which seems to be worth the attention of contractors and railway superintendents. The cut shows well the principal novelty in the design of the car.



A NEW DUMP CAR.

In place of the hinged side commonly used on dump cars of this class, one side of this car is supported by a stout iron, as shown, which is fulcrumed at the center of the car, and is held at its rear end to the frame of the truck. This holds the side of the car in place with absolute security while the car is being loaded or in motion; but when the car is dumped, this side remains nearly stationary, only moving off the center enough to ease the lifting at the start.

The ordinary drop-side dump car, as contractors know, is liable to have its hinges broken by small stones catching on the edge of the drop side when the car is dumped, and is subject to much wear and tear by sudden dropping when unlatched, striking in its fall rock previously dumped, and by other causes. The movable side of the car illustrated is free from these defects, as nothing ever falls over it, and there is no hinge to get clogged.

Besides this feature, special pains have been taken in the design of the car to secure durability at every point. The body and box are solidly constructed and well bolted, but with no pieces larger than can be repaired by the tools in any contractor's kit. We are informed that one contractor, who has used 30 of these cars over six months for hauling rock, states that the cost of repairs has been next to nothing compared with the cost on dump cars of the ordinary type.

The makers of these cars are prepared to furnish them either of 36 ins. gage or standard gage. The smaller cars hold 3 cu. yds., and the standard gage cars, 5 yds. when filled even full or 6 yds. when heaped. The body of the car is equally balanced and the box can therefore be loaded to its full capacity, and is easily dumped by one man. When dumped, the floor of the car is tipped to an angle of 45°, thus insuring the discharge of the entire load, even when handling sticky soils.

The car is put on the market by the Allison Mfg. Co., of Philadelphia, from whom any further information can be obtained.

THE NEED FOR A NEW WATER SUPPLY FOR CINCINNATI, O.

The population contributing to the pollution of the Ohio River, above the point where the water supply for the city of Cincinnati, O., is taken, according to the Cincinnati "Lancet Clinic," is over 730,000 persons. This takes into account the population on the Ohio, Allegheny, Monongahela, Muskingum, Scioto and Little Miami rivers, but disregards that on the Big Sandy, Guyandotte, Kanawha and Little Kanawha rivers, as being comparatively small. About a year ago Dr. Chas. Seth Evans and Dr. J. C. Oliver, editor of the "Lancet Clinic," made biological and chemical examinations of the water of the Ohio River, taken at a point above the junction of the Little Miami River, near California, and from the Eden Park reservoir, after having been pumped from the river.

The results of the biological examinations expressed in colonies of bacteria per cubic centimetre, with the dates the samples were collected, are as follows:

Date.	Eden Park reservoir.	Ohio River at California. Total.	P. C. of bacteria in Eden Park reservoir.
1891:			
Sept. 26	.....	1,307	...
Oct. 2	2,600	2,700	104
" 9	.....	1,440	...
" 10	4,020*	.....	...
" 16	58,480	6,200	11
" 23	14,340	2,240	16
" 28	12,500	5,540	44
Nov. 4	13,920	6,580	47
" 11	54,640**	28,560**	52
" 18	26,200	12,860	49
" 26	35,640	9,080**	25
Dec. 15	13,300	11,620	87
1892:			
Jan. 15	.....	7,510	...
" 21	24,300	.....	...
Feb. 18	16,080	.....	...

* Very low stage of water.
** Sample gathered after heavy rain.

These examinations were made to throw light upon the quality of the supply furnished to the city, and to determine how much better water could be obtained by locating the pumping works further up the river. While the up-river water, with one exception, contained many less bacteria than that from the reservoir, yet its range of from 1,307 to 28,560 bacteria per cubic centimetre, coupled with the fact that a large population contributes to the pollution of the river, puts it far beyond the limit of safe water for domestic uses.

Messrs. Oliver and Evans conclude that the upriver point is preferable for a pumping station, but that purification of the water from that source should be employed.

COST OF LEVELING IN GERMANY.

For the purpose of obtaining accurate information as to the cost of surveys in Germany, a Mr. Gevke publishes in the "Zeitschrift fur Vermessungswesen," 1892, the exact cost and details of primary leveling for the Altenburg water-works. The following is condensed from "Abstracts of Papers," published by the Institution of Civil Engineers.

The total length of line was 13 miles; but the actual length of line twice levelled was 23½ miles.

As to accuracy, the regulations of the Prussian Ordnance Survey were followed, which regards levelling as "good" where the mean error does not exceed 0.7 in. per mile, and "passable," if the mean error does not exceed 1.18 in. per mile. The levelling was generally conducted over well-made roads and footpaths, a part only over meadow land. Of the four bench-marks of the Ordnance Survey connected with the highest was 905 ft. and the lowest, 650 ft. above sea-level. Altogether 51 bench-marks were fixed during the survey. The levelling instrument used had a telescope only 8¼ in. long, and the two rods read directly to 5 millimetres (0.2 in.) according to Nagel's plan. Two iron plates weighing 10 lbs. each, and a large umbrella formed part of the equipment, and a light hand-barrow was used for transporting the instrument.

In conducting the levelling, the instrument was set up midway between two stations, all distances being fixed by pacing. Each rod was numbered on the front side from bottom to top, and the rear side from top to bottom, with a constant sum of the readings on the two sides of 6.1 metres. The observer read the back-sight first on the front and rear side of the rod; the clerk noted these readings in his field book, mentally added them, and if the sum agreed with the constant 6.1 no serious error had been made; two readings were then made on the other rod, held by another rodman at the forward station, the back rodman meanwhile coming up to the observer and moving the instrument to the next station, where the observation was made.

The field work occupied 14 days of seven hours' work each, with an average of 3.35 miles per day levelled for the whole 47 miles of levelling. Altogether the instrument was set up 1,001 times, the average distance between the rods being 258 ft. The shortest sight was 49 ft. and the longest 164 ft.

The pay of the leveller was $37.50 per month, with $1.14 per day added for field expenses. The clerk received $18.60 per month, and 60 cts. per day expenses, and the rodmen were paid 60 cts. per day and 24 cts. expenses. The cost of putting in an iron bench-mark was 28 cts., and there were 37 of these. The total cost, including some miscellaneous items, was as follows:

For fixing bench-marks	$15.64
Salaries, wages and expenses:	
For field work	95.48
For office work	24.20
Miscellaneous expenses	5.60
	$140.92

Thus the total cost of twice levelling one mile was $6. This is interesting rather for describing the methods of German surveyors than for furnishing an estimate of cost in American practice. In another case given by the same author the net cost of levelling two lines of 37.4 and 41 miles was $10.20 and $9.84 per mile, respectively. This latter statement did not include the cost of fixing bench-marks.

ELECTRIC LOCOMOTIVES FOR MINES.

An electric locomotive designed for mining purposes was illustrated in our issue of Jan. 19, and we give below some particulars of service of similar machines. The Brock Coal Co., of Brockwayville, Pa., has a 48-HP. locomotive, and a truck fitted with two 6-HP. motors. The locomotive is used on the outside tramway, about a mile long, with an average of about 2½% grade in favor of loaded cars. The openings, of which there are four working, are located from ⅛ to ¾ mile from the tipple. A fair day's work is the delivering of 500 cars. The 6-HP. truck is working in the openings about 1,000 ft. apart. It handles about 200 cars per day directly from the miners, an average distance of about 2,000 ft., gathering these cars from the miners, forming them into trips of about 15 cars each, on the main heading or drift, and thence hauling them to the drift mouth, whence the locomotive takes them to the tipple. The locomotive and truck are operated from one 56-HP. generator.

The Blossburg Coal Co., of Arnot, Pa., has in its Bear Run mine two 30-HP. electric locomotives, each delivering daily to the head of plane 300 tons in eight hours, and it is thought that they could haul 500 tons each per day of 10 hours. One of them works on the right, and the other on the left hand side of the main heading. They go down into the cross-headings, distribute the empty cars and collect the loaded ones, and very efficiently take the places of the mules formerly used. The longest haul at present is 3,000 ft.; shortest, 1,700 ft. A 3-HP. stationary motor at the foot of the inclined plane receives its current from the power house at the head of the plane, a distance of about 1,300 ft. It is used on the empty car transfer, and drives a sprocket chain which handles 500 empty cars daily over an incline 30 ft. long, of 10 ft. vertical rise, and if kept busy could probably handle 800 cars per day of 10 hours.

STEAM ROAD-ROLLER RULES IN QUEENSLAND.

A bill introduced into the Queensland Assembly "to authorize and regulate the use of steam-rollers upon highways," provides the following rules under which they must be worked: 1. At least two persons shall be employed to drive or conduct the steam-roller. 2. One of such persons, while the steam-roller is in motion, shall precede it on foot by not less than 150 ft., and shall carry a red flag, or at night time an efficient red light, constantly displayed; and shall warn the riders and drivers of horses of the approach of the steam roller, and shall signal the driver thereof when it is necessary to stop, and shall assist horses and carriages drawn by horses, passing the steam roller. 3. A notice shall be affixed in a conspicuous part of the highway, in such a manner as to be easily visible to and legible by all persons approaching within 180 ft. of the steam roller, warning them to beware of the steam-roller. 4. The driver of the steam-roller shall give as much space as possible for the passing of other traffic. 5. The whistle of the steam-roller shall not be sounded for any purpose whatever; nor shall the cylinder taps be opened within sight of any person riding, driving, leading, or in charge of a horse upon the highway; nor shall the steam be allowed to attain a pressure such as to exceed the limit fixed by the safety valve, so that no steam shall blow off when the steam roller is upon the highway. 6. The steam-roller shall be instantly stopped, on the person preceding the same, or any other person with a horse, or carriage drawn by a horse, putting up his hand as a signal to require it to be stopped. 7. Every person in charge of a steam-roller shall provide two efficient lights, to be affixed conspicuously, one at each side on the front of it, between the hours of sunset and sunrise. A penalty of $50 is provided for non-compliance with any of these rules, and a local authority using a roller in contravention of the Act is to be liable for any damage resulting from such contravention.

The Missouri road convention, held at Sedalia, Mo., on Jan. 20, adopted resolutions of the following purport: Work on roads to be done by contract as far as possible; a poll tax of $2 be paid by all able-bodied men over 21 years of age, the same to be paid to the county treasurer, and used as a general county road fund. Roads to be properly located; counties to have the option of making new roads, but to be authorized to levy a tax not exceeding 20 cts. on the hundred dollars for this purpose, and to issue 20-year bonds. A competent supervisor of roads should be appointed for each county, who is to instruct and supervise district overseers. These district overseers should be appointed by the County Court with the advice and consent of county supervisors.

The New York Department of Public Works is to expend $1,243,220 for repaving streets in 1892; $368,080 for granite block and $674,140 for asphalt pavement. The carrying out of this work involves the employment of a consulting engineer at $5,000, an assistant engineer at $3,000, and a proper corps. The City Controller is authorized to employ an engineer at $3,000 a year to watch the progress of this work.

A jib crane for operating the shutters of the dam of an irrigation reservoir is to be used by the Public Works Department of Madras, India. The government has authorized the expenditure of about $1,300 for providing a jib crane to lift the falling-shutters of the Upper Odai dam of the Korampaliam tank or reservoir. According to "Indian Engineering," the want of some mechanical appliance to lift the 48 shutters, each 10 ft. × 6 ft. to 8 ft., and weighing 1,970 lbs. each, has long been felt, as it takes a gang of 14 men every time and 20 minutes to deal with each vent. Colonel Frazer, R. E., sent a sketch for a ratchet wheel lever arrangement with spokes to Burn & Co., of Calcutta, who did not think any really handy appliance for attachment to piers could be made, and submitted a drawing of a light wrought iron crane traveling on a trolley on a meter gage track. The sweep of jib is 13 ft.; this might be slightly reduced if the chain laid hold of the gates a little lower down, say, to 11 ft. 6 ins. sweep. The jib would revolve, and the crane would also be of great utility in shipping and unshipping the shutters.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF DECEMBER, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—(rain and melted snow)—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	17.8	40	-11	51	8.1	42	N	1.13	0.51	13
	Portland, Me.	25.0	46	-5	51	7.3	24	NW	1.32	0.73	8
	New York, N. Y.	31.3	58	9	49	11.1	38	NW	1.64	0.61	9
	Pittsburg, Pa.	31.3	70	3	67	6.8	24	NW	1.92	0.90	17
	Chicago, Ill.	23.4	57	-10	67	15.7	50	SW	1.51	0.86	11
	Omaha, Neb.	21.6	59	-14	73	8.0	32	NW	1.79	1.30	10
	St. Paul, Minn.	14.8	41	-17	58	6.7	21	NW	0.53	0.16	8
	Duluth, Minn.	13.9	42	-19	61	5.9	28	NW	0.15	0.06	6
	Bismarck, N. Dak.	10.4	42	-20	62	6.9	36	NW	0.16	0.08	7
	Average	21.1	50.6	-9.3	59.9	8.3	32.2		1.14	0.58	10
Southern Cities.	Washington, D. C.	33.2	67	13	54	6.2	35	NW	2.82	1.76	8
	Louisville, Ky.	35.0	71	4	67	6.7	29	S	2.07	1.11	9
	St. Louis, Mo.	33.0	63	-2	65	10.6	42	SW	1.99	1.27	10
	Savannah, Ga.	53.3	77	25	52	6.9	29	S	3.17	1.01	9
	Leavenworth, Kan.	26.0	67	-11	78	6.9	40	NW	1.77	0.53	6
	Jacksonville, Fla.	57.6	80	30	50	6.4	42	SW	2.52	1.05	9
	Chattanooga, Tenn.	40.4	66	12	54	4.9	20	SW	4.49	1.51	11
	New Orleans, La.	55.8	79	23	56	10.0	40	E	3.22	0.95	8
	Memphis, Tenn.	40.8	76	13	63	7.3	35	SW	11.95	4.50	14
	Palestine, Tex.	48.5	80	15	65	6.6	25	N	11.04	3.24	14
	Average	42.4	72.6	12.2	60.4	7.2	33.8		4.50	1.69	10
Western Cities.	Helena, Mont.	21.4	47	-22	69	8.0	36	SW	0.56	0.22	14
	Port Angeles, Wash.	38.4	49	18	31	5.6	35	NE	5.15	0.66	25
	San Francisco, Cal.	51.1	64	38	26	9.1	60	SE	5.08	2.31	10
	Salt Lake City, Utah	27.6	55	-1	56	4.9	35	NW	2.35	0.70	18
	Denver, Colo.	26.8	67	-9	76	7.1	36	NW	1.34	0.54	8
	Yuma, Ariz.	53.1	79	28	51	6.5	43	N	T	T	0
	Santa Fé, N. Mex.	28.6	55	6	49	6.8	25	N	0.70	0.30	7
	Average	31.2	52.0	7.2	44.8	6.0	73.8		1.88	0.58	10

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

WILMINGTON & NORTHERN.—This company is considering the construction of a freight branch from Lenape to West Chester, Pa.

PERRY COUNTY.—The branch from New Bloomfield to Landisburg, Pa., 12 miles, has been completed. The grading and about four miles of track were completed last year.

FINDLAY, FT. WAYNE & WESTERN.—At the recent meeting of the stockholders of this company the capital stock was increased from $1,440,000 to $3,000,000. It is stated that the money will be used to extend the road east from Findlay to New London, O.

CLEVELAND, WOOSTER & MUSKINGUM VALLEY.—A bill is now before the Ohio state legislature changing the charter of this company so as to allow the Baltimore & Ohio R. R. Co. to assume formal control of the line. It is stated that this is preliminary to an extension from Lodi north to Cleveland, O.

OHIO SOUTHERN.—This company has filed a mortgage made to the Central Trust Co., of New York, N. Y., for $4,000,000. The money is to be used in constructing the proposed extension from Springfield to Lima, O., the locating surveys for which have just been completed.

GRANITE HILL.—This company, whose incorporation was noted last week, has completed its line from Granite Station to Granite Hill, Pa. Pres., David Wills, Gettysburg, Pa.

FALL BROOK COAL CO.'S—The contract for the branch from Mills to Ulysses, Pa., 7.1 miles, has been let to Albert J. Hines & Co., of Corning, N. Y.

Projects and Surveys.

KEESEVILLE & SARANAC LAKE.—The citizens of Keeseville, N. Y., have subscribed $2,500 for a survey for a railway from that place to Keene and Saranac Lake.

BUSTLETON & EASTERN.—Chartered in Pennsylvania to build a railway from Bustleton, Pa., to Falsington, Pa., 14 miles. Pres., Sam. Rea, Bryn Mawr, Pa.

BROADALBIN & AMSTERDAM.—Surveys are nearly completed for this line from Amsterdam to Broadalbin, N. Y. Ch. Engr., F. W. Brown, 34 North Main St., Gloversville, N. Y.

Southern.—Existing Roads.

JELLICO & BIRD EYE.—The grading has been completed on this 7½-mile railway, from Jellico to Bird Eye, Ky., and tracklaying will begin as soon as the weather permits.

VIRGINIA.—The contract has been let to Gooch & Waugh to build a railway three miles long from Covington, Va., to the Dolly Ann mines. Frank Lyman, Covington, Va.

HOLSTON VALLEY.—The contract for building ten miles of this railway from Bristol, Tenn., to the mouth of Big Creek, has been let to A. T. Smalling, of Piney Flats, Tenn.

Projects and Surveys.

NORTH CAROLINA.—Bills to incorporate the Atlantic & Ohio R. R. Co. and the Burlington & Southwestern R. R. Co., are before the North Carolina state legislature.

LOUP CREEK & PINEY.—This company, whose incorporation in West Virginia was recently noted, proposes to build a standard-gage road from a point on Upper Loup Creek, in Fayette Co., W. Va., to a point on Piney Creek, near the mouth of Boyer's Fork, in Raleigh Co., thence down Piney Creek to the mouth of Little White Stick, in the same county. The principal office of the company will be at Charleston, W. Va. The subscribed capital is $100,000, and is held by S. H. Carter and Samuel Spicer, of New York city; A. H. Gillard, W. S. Townsend and T. W. Joyce, of Brooklyn, N. Y. One terminus of this road will form a junction with the line which the Chesapeake & Ohio is now building up Loup Creek to the McKell coal lands.

Northwest.—Existing Roads.

DULUTH, MISSISSIPPI & NORTHERN.—A contract has been awarded for constructing 12 miles of new track on the Mesaba Iron Range, to John J. Granville, C. E., of East Saginaw, Mich. Mr. Granville informs us that 22 miles of this system are in operation, and that 19 miles are under construction. W. A. Dafter, Swan River, Minn., is Chief Engineer.

DULUTH, PIERRE & BLACK HILLS.—A press dispatch from St. Paul, Minn., dated Jan. 21, says: "The Directors of the Duluth, Pierre & Black Hills R. R. Co., to-day held a meeting in Pierre, and ratified a contract for completing the grade, bridging, ironing and operating the road from Aberdeen to Pierre, S. Dak., a distance of 130 miles. About one hundred miles of this road has already been graded, leaving only thirty miles to complete the line. The contract was made with James A. Larned, as the representative of New York parties. Under the contract the laying of iron must be commenced not later than July of the present year and prosecuted as rapidly as possible. The iron has already been arranged for. This line is intended for a link in a through line from St. Paul and Duluth to the Black Hills and Denver.

YANKTON, NORFOLK & SOUTHWESTERN.—This company has given a mortgage of $975,000 to the Atlantic Trust Co., of New York, N. Y.; the proceeds to be used in completing its line from Yankton, S. Dak., to Norfolk, Neb.

BURLINGTON & MISSOURI RIVER.—The contract for a branch to Spearfish, S. Dak., is reported let to Kilpatrick Bros., & Collins.

Projects and Surveys.

MINNESOTA.—A press dispatch from Minneapolis, Minn., says: A railroad is to be built from this city to the Itasca iron district. It will leave Minneapolis in the Columbia Heights district and run on an air line to St. Francis on the Northern Mississippi and northwest of this city. From that point it will take a northeasterly direction, and will tap the heart of the Itasca district. It will run through a country which has no railroad connections at present.

HIGHLAND & DODGEVILLE.—A survey has been completed for a railway from Highland to Dodgeville, Ill., 25 miles. It is reported that the road will be built at once.

EMPIRE TIMBER CO.—This company, with offices at Eau Claire, Wis., is preparing to build 20 miles of railway.

CLAYTON & PEA RIDGE.—It is announced that this company is making preparations to begin the construction of its line from Clayton, Ill., to coal fields in the western part of Schuyler, Ill., to coal fields in the western part of Schuyler Co. Pres., G. W. Montgomery, Mt. Sterling, Ill.

Southwest.—Existing Roads.

TEXAS MIDLAND.—Surveys will be made at once for the proposed extension from Roberts to Paris, Tex.

Projects and Surveys.

NORTH ARKANSAS.—The officers of this company, recently chartered to build a railway from Ravenden Station to Ravenden Springs, Ark., are: Pres., P. Ariund; Vice-Pres., and Gen. Man., R. D. Welch; Secy., G. C. Bufford, and Treas., H. G. King.

EXCELSIOR SPRINGS.—The following officers have been elected by this company: S. F. Scott, Pres. and Gen. Man., Kansas City, Mo.; H. M. Holden, Vice-Pres., Kansas City; H. E. Robinson, Treas., St. Louis; W. A. Butterfield, Secy., Excelsior Springs, Mo., and F. S. Mitchell, Chf. Engr., St. Louis.

Rocky Mt. and Pacific.—Existing Roads.

GREAT SALT LAKE & HOT SPRINGS.—The Utah & Nevada Coal & Construction Co., has been chartered to operate and control coal mines in Utah and Wyoming, and to build a railway line thereto. It is stated that the first construction work of the company will be to extend the above line from Bountiful to Coalville, Utah. The officers are: Pres., Allen G. Campbell; Vice-Pres., W. W. Chisholm; Secy., Simon Eiseman; Treas., S. J. Kenyon; Gen. Man., H. H. McCartney.

NORTHERN PACIFIC.—The contract for building the Burrard Inlet & Fraser Valley R. R., from Sumas, Wash., to Vancouver, B. C., has been let to Dickinson & Co., of Tacoma, Wash. It is stated that work will begin at once.

CALIFORNIA & NEVADA.—This company is reported to be constructing a 5-mile extension.

UNION PACIFIC.—The announcement is again made that work will soon begin on the Portland-Seattle line. Pres. S. H. H. Clark is given as authority for the announcement.

Projects and Surveys.

FRESNO & MONTEREY.—The directors of this company, whose incorporation was noted in our last issue, are: A. W. Jones, Kansas City, Mo.; C. C. Walter and Alex. Gordon, Fresno, Cal.; H. A. Green, Monterey, Cal.; W. C. Hill, Salinas, Cal., and Wm. Palentag and Thos. Flint, Hollister, Cal. Surveys will, it is stated, be begun at once.

DALLES-CELILO.—A bill has been introduced into the Oregon state legislature authorizing the state to construct a portage railway between The Dalles and Celilo, Ore., and to appropriate $460,000 for the purpose.

ROCKY MT. & PUEBLO.—Organized in Colorado to build a railway from Pueblo to Overton, Colo. John Coon, Geo. A. Hobson, A. E. Graham and A. J. Overton, all of Pueblo, Colo.

SAN FRANCISCO & SANTA CLARA VALLEY.—An official of this company is reported as saying that construction will begin on the main line from Ravenswood to Gelroy, Cal., immediately, and that 23 miles from Ravenswood south will be completed by May 1. W. R. A. Johnson, San Francisco, Cal.

Foreign.

TEHUANTEPEC.—A press dispatch from the City of Mexico, says: "The prospect for the completion of the Techuantepec Ry. by June 21 is good. If the line is finished by the date the contractors will receive a bonus of $50,000 from the Mexican Government. There are 125 kilometres of track laid on the Gulf side of the isthmus and 120 kilometres on the Pacific side, leaving a gap of some 70 kilometres to be completed. The heaviest work has been completed, and the greatest obstacles now are the construction of bridges across three large rivers. Salina Cruz, the Pacific terminus of the road, is destined to become a great seaport, and extensive harbor works will soon be inaugurated by the government, an enormous breakwater and pier being among the necessities to make Salina Cruz an available seaport to accommodate the immense traffic that will ensue on completion of the road. On the Gulf side, a system of jetties, similar to those at Tampico, will be constructed.

ELECTRIC RAILWAYS.

COLORADO SPRINGS, COLO.—It is proposed to build an electric railway to Cripple Creek. Frank Earle and C. B. Wilder, Colorado City, Colo.

READING, PA.—A company has been organized to build an electric railway to the Temple Inn, about five miles. Pres., John A. Rigg; Vice-Pres., Mathias Moyre; Secy. and Treas., Frank S. Livingood.—The Mayor has signed the bill granting the City Passenger Ry. Co. power to use the electric trolley system. The company controls about 80 miles of line.

LANCASTER, PA.—Chartered, Lancaster & Philadelphia Electric St. Ry. Co., Lancaster to Philadelphia, Pa.; capital stock $1,500,000; John D. Patterson, Mifflintown, Pa.

LOUISVILLE, KY.—The Kentucky & Indiana Bridge Co. has decided to equip its road to New Albany, Ind., with electricity.

NATCHEZ, MISS.—The Natchez St. R. R. Co. will change its motive power to electricity. Secy., Abe. Moses.

MEMPHIS, TENN.—The East End Ry. Co. will change its motive power to electricity. Gen. Man., G. H. Bunch.

DENVER, COLO.—The Denver & Westminster Ry. Co., recently chartered, proposes to build an electric railway 18 miles long. The road will be standard gage. No contracts have been let. H. A. Whiting, 1,648 Curtis St., Denver, Colo.

CHICAGO & ST. LOUIS ELECTRIC RY.—It is reported that the contract for this proposed electric railway from Chicago to St. Louis, Mo., has been let to Bagnell Bros., of St. Louis, Mo. The contract does not include the electric plant.

ELEVATED RAILWAYS.

CHICAGO, ILL.—A contract has been let by the Metropolitan West Side Elevated R. R. Co., to Carnegie, Phipps & Co., of Pittsburg, for the construction of 14 miles of road at a price approximating $3,000,000. The contract is upon the basis of a fixed price per pound for the iron in the form of a completed roadway, as per specifications, the work to be completed by Feb. 1, 1894. The railway company agrees to have the right of way ready as fast as needed, and has already secured one mile of it, beginning at a point about a half mile west of the city limits, immediately south of Harrison St.

HORSE AND MOTOR RAILWAYS.

BEDFORD CITY, VA.—A franchise for a street railway has been granted to M. H. Clayton.

DUNDEE, ILL.—The Dundee Rapid Transit Co. has been chartered to build a street railway. Edgar C. Hawley, G. Frank Oatman, Wm. Fay.

HIGHWAYS.

CONNECTICUT.—The selectmen of Berlin have been petitioned to call a special town meeting to discuss the question of better highways.

NEW YORK.—Ricker & Wing, Buffalo, are preparing surveys for the completion of the boulevard between Buffalo and Niagara Falls. The roadway has been built from Buffalo Park to the Eggertsville Road, and preliminary surveys completed to the north city line of Tonawanda. It is reported that the legislature will be petitioned to make it a state road.

NEW JERSEY.—The Hudson Co. Board of Freeholders desires authority to spend $1,000,000 more on the new county road. The road will be 14 miles long and the right of way has cost about $630,000. The present appropriation is sufficient only for a dirt road and a macadamized one is proposed. The board also voted in favor of constructing a loop to connect with Hoboken. This will be about four miles in length and cost about $700,000.

MARYLAND.—The Supervisors of Kent Co. are reported as about to advertise for proposals to keep the roads in repair. The total mileage is 525, and the work heretofore has been in charge of 116 supervisors.

BRIDGES, TUNNELS AND CANALS.

HARRISBURG, PA.—A company will soon be organized to build a bridge across the Susquehanna River at this place. The bridge will consist of 28 spans of 150 ft. each.

NEW ORLEANS, LA.—The bill authorizing the construction of a bridge over the Mississippi River has passed both houses of Congress. The Southern Bridge & Ry. Co. is the company which will carry out the project.

WACO, TEX.—The Texas Midland Ry. is considering the construction of a bridge across the Brazos River.

ROCHESTER, N. Y.—The following is a detailed list of the prices for doing the various classes of work in the stone arch bridges at Andrews and Court streets. The contract for the Andrews St. bridge was awarded to Ellsworth & Grant, and for the Court St. bridge to Lauer, Hagaman, Brayer & Albaugh. A brief description of these structures will be found in another column.

Names of Bidders for Andrew St. Bridge.	Removing old bridge and material.	1,900 cu. yds. earth excavation for abutments and piers.	480 cu. yds. masonry in abutments, including backing.	804 cu. yds. masonry in piers, including cutwaters and concrete filling below skewbacks.	131 cu. yds. skewbacks to dimensions.	1,313 cu. yds. arch stones.	325 cu. yds. spandrel walls, including concrete backing.	250 cu. yds. rubble masonry.	1,224 cu. yds. concrete in spandrel backing, not including that mentioned in fourth item.	560 lin. ft. coping.	Drip pipes from spandrel spaces through arches.	1,000 cu. yds. gravel for filling spandrels and at both ends of bridge to grade up street.	560 lin. ft. curbstone on bridge.	2 surface sewers, with drain pipes through arches.	1,245 sq. yds. Medina block pavement, including concrete foundation, sand and paving cement.	436 sq. yds. asphalt paving, including concrete foundation.	532 lin. ft. hand rail, including setting stone bolts for same	600 sq. yds. Medina stone pavement relaid.	300 lin. ft. curbstone reset.	800 lin. gutter stones relaid.	4,500 sq. ft. sidewalk flagging relaid.	Totals.
Chambers & Casey	$1.00	$1.00	$9.75	$16.50	$31.00	$19.00	$10.00	$7.50	$7.00	$3.50	$10.00	$1.00	$0.95	$55.00	$3.80	$2 75	$2.39	$0.50	$0.10	$0 10	$0 05	$73,873.60
Ellsworth & Grant	5.00	.85	9.50	17.00	32.00	20.00	11.00	7.00	5.00	3.00	10.00	.90	.90	50.00	3.70	2.70	2 20	60	.10	.10	.07	72,337.10
Whitmore, Rauber & Vicinus	50.00	.90	9.50	16.00	34.00	20.50	10.00	7.00	5.50	3.10	7.00	.90	.85	48.00	3.70	2.50	2.10	.60	.10	.10	.05	72,945.20
B. P. Smith	10.00	.90	10.00	17.25	30.00	20.25	11.25	8.00	5.25	3.00	8.00	.85	.85	47.00	3.65	2.65	2.25	.60	.10	.10	.05	73,420.55

Names of Bidders for Court St. Bridge.	Removing old bridge and material.	2,200 cu. yds. earth exc for abutments and piers.	4,700 cu. yds. rock ex. in river, and foundations.	622 cu. yds. masonry in abutments. In cluding backing, inclined courses in west abutment and connections with old walls.	1,230 cu. yds. masonry in piers in open cofdine pier in center of race, including cutwaters and concrete filling between skew-backs.	75 cu. yds. masonry in pier in center of race.	160 cu. yds. skewbacks to dimenstones.	2,218 cu. yds. arch stones.	636 cu. yds. spandrel walls, not including concrete back.	2,000 cu. yds. concrete in spandrel backing, not including that mentioned in item 4th.	868 lin. ft. coping.	5 drip pipes from spandrel spaces through arches.	3,500 cu. yds. gravel for filling spandrels and to grade up street.	308,600 lbs. wrought iron in span over canal, erected complete and including necessary stone bolts.	9,800 lbs. cast iron bed plates and cylinders over ends of girders.	450 lbs. steel in friction rollers.	1,008 lin. ft. curb-stone, new.	160 sq. ft. stone, laid below curb-stones and gutter.	1,008 lin. ft. gutter stones, new.	4 surface sewers, with drain pipe through arches.	2,091 sq. yds. Medina block paving, including concrete foundation, and paving cement.	932 sq. yds. asphalt paving, including concrete foundat'n.	319 sq. ft. asphalt on top of girders.	1,008 lin. ft. hand rail, including resting stone bolts.	260 sq. yds. Medina stone pavement, rel-id.	270 lin. ft. curb-stone, reset.	1,350 sq. ft. sidewalk flagging, relaid.	Totals.
Chambers & Casey	$10.00	$0.90	$1.30	$8.50	$16.00	$25.00	$32.00	$30.00	$11.00	$6.50	$3.00	$10.00	$0.95		$0.03	$0.10	$0.90	$0.10	$0.45	$3.70	$2.30	$0.30	$2.00	$0.65	$0.10	$0.10	$0.05	$148,549.90
Whitmore, Ranber & Vicinus	5.00	.91	1.45	10.00	17.50	23.00	34.00	22.00	10.00	6.50	3.00	7.00	.90		.034	.12	1.20	.37	.60	3.80	2.10	.25	2.15	.65	.10	.07	.05	153,678.25
*Lauer, Hogan'n, Bray'r & Albaugh	100.00	.55	2.50	9.00	15.00	24.00	25.00	18.00	8.00	5.50	3.00	10.00	.90		.03	.06	1.00	.40	.65	3.50	2.00	.25	2.00	.60	.10	.10	.05	157,021.05
Ellsworth & Grant	400.00	.91	1.35	9.50	15.00	23.00	25.00	20.00	11.00	6.00	4.00	7.00	1.00		.03	.06	.90	.40	.75	3.75	2.15	.30	2.25	.75	.10	.10	.05	159,609.25
Robinson & Pond	10.00	.69	2.00	13.00	19.00	29.00	34.00	30.00	10.50	7.50	3.00	9.00	.85		.03	.07	.90	.40	.75	3.95	2.15	.27	2.25	.80	.10	.10	.05	151,855.98
R. P. Smith	2.00	1.05	1.30	10.50	19.00	22.00	34.00	20.00	10.50	7.50	3.00	9.00	1.05		.03	.07	.90	.40	.75	3.95	2.15	.27	2.25	.80	.10	.10	.05	151,855.98

* Awarded contract.

WATER-WORKS.

New England.

OAKLAND, ME.—A bill to extend the charter of the Oakland Water Co. has been introduced in the legislature.

PITTSFIELD, ME.—It is reported that a town meeting to discuss the building of works will soon be called.

SEAL HARBOR, ME.—A bill has been introduced in the legislature to incorporate the Seal Harbor Water Co.

UNION, ME.—Application for the incorporation of a company will be made.

ENOSBURG FALLS, VT.—Water and electric lighting plants are proposed by the village.

FALL RIVER, MASS.—An 8,000,000-gallon pumping engine may be added.

LOWELL, MASS.—A contract for a 10,000,000-gallon driven well plant has been awarded to the Cook Well Co., Chicago and St. Louis, for $4,850 per million gallons..

SPRINGFIELD, MASS.—It is reported that the contract for cast iron pipe for the new supply main from the city to Ludlow has been awarded to the Warren Foundry & Machine Co., New York.

WATERBURY, CONN.—The Council has adopted the recommendation of the Water Commissioners that a new supply be introduced from Hop Brook. Authority to issue bonds must yet be secured.

Middle.

AUBURN, N. Y.—The Water Commissioners have recommended that the city buy the company's works for $425,000, rather than build an independent system.

FLATLANDS, N. Y.—H. H. Wheeler and Frederick Munch, representing Brooklyn parties, have applied for a franchise. Richard L. Baisley, Canarsie, is Supervisor of the town.

GARDINERY, N. Y.—Works, with a supply from springs, is talked of.

HIGHLAND, N. Y.—J. P. Hayden, Aaron Rhodes and others propose to incorporate a company; about $10,000 of stock subscriptions have been secured.

NEW YORK, N. Y.—Bids are wanted until Feb. 9 for building foundations for high service pumping works at the new aqueduct, between Tenth Ave. and the Harlem River. M. T. Daly, Comr. Pub. Wks.

SCHENECTADY, N. Y.—Bids are wanted until Feb. 6 for pipe, trenching and pipe laying. Address Water Commissioners.

SOUTHAMPTON, N. Y.—Works are again proposed.

SPRING VALLEY, N. Y.—The Spring Valley Water-Works Co. has been incorporated; $10,000; Pres., P. B. Lespinasse; Secy., J. Donald Dunlap.

WEST TROY, N. Y.—It is stated that a bill authorizing the town to issue bonds to build works will be sent to the legislature. A company now supplies water.

BOONTON, N. J.—A franchise has been granted to Lewis Van Dyne; the town to take 50 hydrants at a rental of $1,000 per year. It is said that water will be pumped to a reservoir from Rockaway Valley Brook, three miles distant.

SOUTH AMBOY, N. J.—The Borough Council has recommended that works, including a stand-pipe, be built, the supply to be obtained from Perth Amboy; estimated cost, $30,000.

McSHERRYSTOWN, PA.—The McSherrystown Water Co. is reported as organized with a stock of $10,000; Pres., Vincent O. Bald; Secy., A. J. Brady.

Southern.

NORFOLK, VA.—The Metropolitan Development Co. has been incorporated to operate water, gas, pneumatic power and electric works; $100,000 to $1,750,000.

ELIZABETH CITY, N. C.—Works are proposed. W. C. Glover, Mayor.

FAYETTEVILLE, N. C.—We are informed that the Fayetteville Water, Light & Power Co., recently incorporated, will begin work at once. No contracts for material have been let. There will be required: A 100-HP. high speed engine; 6×16-ft. steel return tubular boiler, with 71 4-in. flues; 30-in. turbine wheel; 1,000,000-gallon steam and 750,000-gallon duplex power pump; 550 tons 10 to 4-in. cast iron pipe, 51 double hydrants, and 30 10 to 4-in. valves; a 13×100-ft. wrought iron stand-pipe. The plant is to be completed by next May. Address Ferris & Richards, 98 Hudson St., Jersey City, N. J.

North Central.

CLEVELAND, O.—Bids will be received until Feb. 8 for such cast iron pipe and specials as may be needed this year, including 4,400 ft. of 36-in. and 20,000 ft. of 36-in.; also until Feb. 23 for about 300 gates, from 48 to 4-in., and 250 4 and 6-in. double hydrants. R. R. Herrick, Dir. Pub. Wks.

MANSFIELD, O.—A 16×100-ft. stand-pipe is under discussion, together with an additional supply from the Hedges springs.

EVANSTON, IND.—Preliminary examinations have been made for works by Bernhard Feind, Rookery Building, Chicago.

ROCKVILLE, IND.—Works are proposed.

BLOOMINGTON, ILL.—The Illinois Municipal Improvement Co. has been incorporated to operate electric light and water-works plants, whether here or elsewhere, not stated; $50,000. The city owns works.

BUSHNELL, ILL.—The city wishes to sell or lease its works to someone who will introduce a new supply of 300,000 gallons per day from Withard Springs through about four miles of 8-in. pipe. J. B. Spiers, C. A. Harrah, A. H. Roman, W.-Wks. Com.

PEORIA, ILL.—The Spring Water Co. has been incorporated; $5,000.

MILWAUKEE, WIS.—It is said that the lowest bid for 1,000 tons of cast iron pipe was $24.74 for 16, 8, 6, 4 and 3-in. pipe, from the Addystone Pipe & Steel Co., Cincinnati.

SOUTH MILWAUKEE, WIS.—T. Gray, Whitewater, has made a proposition to the South Milwaukee Co. to construct water and sewerage systems.

Northwestern.

FOREST CITY, IOWA.—Works are talked of, merely.

CAWKER CITY, KAN.—The "Times" is in favor of building works.

CHANUTE, KAN.—Works are proposed. S. C. Brown, Cy. Atty.

HORTON, KAN.—Negotiations for works, to cost about $40,000, are said to be under way.

HARTINGTON, NEB.—The people voted to put in works Jan. 24.

LANDER, WYO.—The exclusive franchise granted to the Rocky Mountain Water Supply Co. has been revoked, and it is said that there is now a chance here for capitalists.

PHILLIPSBURG, MONT.—The M. & J. K. Water Co. has been incorporated to supply water for domestic and irrigating purposes; $100,000.

Southwestern.

ABILENE, TEX.—It is stated that surveys for two dams on Lytle Creek have been made by Alexander Lane, Chicago, and that bids for their construction will be wanted; estimated cost, $60,000 for the upper and $40,000 for the lower structure.

EL PASO, TEX.—The Council has awarded a contract for works, conditioned on the city selling its bonds, to Rhodes Bros., Denver, Colo., for $171,000. The contract does not include the wells and a 3,000,000-gallon pumping plant, which has been awarded to the Cook Well Co., St. Louis, Mo., for $28,000. A company already supplies the city, and will attempt to prevent the building of city works, it is said.

HUTTO, TEX.—It is reported that works are to be built.

NORMAN, OKLA.—The council proposes to secure bids for putting in works, after which a popular vote on the question will be taken.

PUEBLO, COLO.—It is reported that Engr. C. F. Allen, Denver, is interested in a proposed new gravity supply, possibly from a source 23 miles distant, with a 20,000,000-gallon reservoir and a filtering system; estimated cost, $800,000.

COLORADO SPRINGS, COLO.—Engr. Rudolph Herring, New York, will report upon improvements, with a view to secure better pressure in north end of the city.

Pacific.

PORTLAND, ORE.—Bids for a new supply main are wanted, as stated in detail in our advertising columns.

MODESTO, CAL.—Bids will be received until Feb. 13 for constructing a complete system of works, with Worthington pump, Mathews hydrants and Eastern-made cast iron; also alternative bids on other makes of pumps, hydrants, and on Oregon cast iron. Geo. H. Golden, Cy. Clk.

PASO DE ROBLES, CAL.—The Crystal Spring Water Co. has been incorporated; $150,000; it is said that the principal office will be at Stockton. A company already supplies the place.

SEWERS.

BENNINGTON, VT.—We are informed by J. T. Shurtleff, Secy. Sewer Com., that surveys for a system of sewers have been prepared by McClintock & Woodfall, Boston, Mass., and that estimates and specifications are now being prepared, to be submitted at the village meeting in April.

ATTLEBORO, MASS.—Chief Engineer Stearns, of the State Board of Health, has been in town consulting with W. J. Luther, C. E., and others concerning the proper drainage of the eastern part of the town.

MELROSE, MASS.—We are informed by Walter C. Stevens, Cy. Engr., that he is preparing surveys and plans for a sewerage system for the entire town, including about 45 miles of streets. The town is hilly, and considerable rock excavation is expected, while the low parts are underlaid with quicksand. A newly designed flush tank will be included in the plans, one to be placed at the highest point of the sewer in each street.

EAST GREENWICH, R. I.—Surveys and plans for a system of sewers are being prepared by Shedd, Sarle & Shedd, Providence.

WOONSOCKET, R. I.—The City Council has appropriated $10,000 for sewers, and voted to issue sewer bonds for $100,000.

BERWICK, PA.—The borough will vote Feb. 21 on the sewer question. Plans and specifications have been prepared by Alexander Potter, Olean, N. Y. The estimate for the portion to be built at present is $45,000 for eight miles of pipe sewer.

MEADVILLE, PA.—We are informed that the council will readvertize for bids for plans for a sewerage system.

MONONGAHELA CITY, PA.—We are informed by Geo. D. Jenkins, Cy. Engr., that last fall the city put in a part of a separate system of sewers.

SMYRNA, DEL.—Wm. Faries, J. C. Robinson and J. H. Hoffecker have been appointed a committee to investigate the question of a system of sewerage. The issue of bonds is proposed.

CANTON, O.—The contract for sewage disposal works machinery has been awarded to the Bonnot Co., Canton, at $4,700 for plant complete and in working order, comprising 1 low service sludge pump, 1 high service sludge forcing pump, 2 double chemical mixers, 1 agitating engine, 1 60-chamber filter press, 1 turn table and car and track, and 1 tubular boiler, 54 ins. × 12 ft. This was the only bid that included complete plant and guarantee for its successful operation. Other bids were: H. R. Worthington, New York, pumps only, $196 and $312; Smith & Valle Co., Dayton, O., pumps set up, $350 and $431; filter press set up, 50 chambers, $1,515; L. B. Harting, Canton, pumps set up, $235 and $273; boilers complete, $834. Bids will probably be asked this spring for 1¼ miles of 6-ft. outfall storm sewers. L. E. Chapin, Cy. Engr.

MARIETTA, O.—We are informed by E. Frank Gates, Cy. Engr., that plans for a separate system were prepared last fall by J. W. Hill, Cincinnati; and that the city hopes to construct at least one district this season.

VAN WERT, O.—We are informed by G. L. McKibben, Cy. Engr., that preliminary surveys have been made for a brick sewer, and the work will probably be done this summer.

ALTON, ILL.—We are informed by Geo. Dickson, Cy. Engr., that the city will build about a mile of sewer this season.

CLEVELAND, O.—The Director of Public Works will receive bids until Feb. 15 for six sewers, and until March 1 for two; one in Michigan St. and the other in Detroit St., with an outlet into the Cuyahoga River.

KENOSHA, WIS.—We are informed by F. F. Foote, Cy. Engr., that plans have been completed and bids will be asked in a few days for 4,200 ft. of brick and pipe sewer; estimated cost, $14,000.

MINNEAPOLIS, MINN.—The Committee on Sewers has decided to ask for bids for 1,000,000 sewer brick.

FORT SCOTT, KAN.—We are informed by G. B. Phinney, Cy. Engr., that the city is constructing a separate system of sewers and that a contract has been recently awarded to John McDonald, at $14,900, as follows: 15-in. vitrified pipe, 1,740 ft.; 10-in., 1,742 ft.; 8-in., 864 ft.; 6-in., 7,034 ft.; 13 manholes, and 9 flush tanks.

ST. CHARLES, MO.—The city is considering the proposition of a St. Louis construction company to put in a complete sewerage system.

BOULDER, COLO.—It is reported that a sewerage system five or six miles in length can be constructed for about $30,000.

BOISE CITY, IDAHO.—Plans have been agreed upon for a sewerage system for the State Penitentiary, the outlet being into the Boise River.

FRESNO, CAL.—We are informed by J. D. Etter, Cy. Engr., that a special election will be held March 4 to vote on the issue of bonds for $75,000—to run 20 years at 5%—to complete the construction of the sewerage system.

MODESTO, CAL.—The Board of Trustees will receive bids until Feb. 13 for a complete system of sewers; bids to be received for material only, construction only, or both. Geo. H. Golden, Cy. Clk.

REDLANDS, CAL.—Bids are asked until Feb. 8 for the construction of 12 and 14-in. salt glazed vitrified pipe, and 20-in. double dipped and double riveted steel pipe sewers; bids to be received for the sewers complete, or for work, steel, and clay pipe separately. L. W. Clark, Cy. Clk.

UKIAH, CAL.—The estimated cost of a sewerage system is $50,000.

STREETS.

BUFFALO, N. Y.—Additional paving to cost about $80,000 has been ordered.

HUNTINGDON, PA.—The citizens are agitating the question of brick paving. It is claimed that this would cost about $1.80 per sq. yd., and last 25 years, and that the present macadam roads cost about $1.20 per sq. yd.

YORK, PA.—The Highway Committee has been instructed to readvertise for bids for the street paving, the new specifications requiring the dirt to be hauled 1,500 yds., if required. In our issue of Dec. 22 we noted that the contract for about 10,000 sq. yds. of paving with asphalt blocks had not been awarded, and that the committee had recommended that it be awarded to the highest bidder; bids ranging from $2.43 to $2.97 per sq. yd.

TITUSVILLE, PA.—We are informed by Joseph Smith, Cy. Engr., that the city has about 1,500 lin. ft. of street to be paved with Franklin paving brick, now under contract, and that the citizens are taking steps to have about 2,500 lin. ft. additional paved early next season.

JACKSONVILLE, FLA.—Bay St. is to be repaved, but whether with vitrified brick, asphalt blocks, granite blocks, or sapless cypress blocks, has not yet been decided.

CINCINNATI, O.—The Board of Administration will receive bids until Feb. 27 for grading, curbing, flagging, macadamizing and bowidering; two contracts.

NILES, O.—It is proposed to issue bonds for $20,000 or $25,000 to open a new street.

PEKIN, ILL.—We are informed by John R. Seibert, Cy. Engr., that the city has under consideration 14,900 sq. yds. of paving, for which bids will soon be asked.

OSHKOSH, WIS.—The Board of Public Works will receive bids until Feb. 20 for grading, stone curbing and cedar block paving in six streets.

DES MOINES, IA.—The City Council has voted to pave in 15 streets with brick, concrete, cedar blocks, granite blocks, or asphalt, and in three with macadam.

BEATRICE, MD.—At the special election Jan. 24 the proposition to issue paving bonds for $20,000 was defeated by a vote of 321 to 301.

MARSHALL, MO.—Bids will soon be asked for about ¾-mile of macadamizing and paving.

MOBERLY, MO.—We are informed by H. V. Estill, Cy. Engr., that the city will probably lay about 8,666 sq. yds. of brick paving this summer, in addition to the 1,867 sq. yds. for which the contract is noted elsewhere.

SEDALIA, MO.—We are informed by C. H. Zoll, Cy. Engr., that in the spring the city proposes to pave East 3d, West 5th, and East 7th Sts.

LITTLE ROCK, ARK.—Bids are asked until Feb. 16 for brick paving. J. J. Jung-Kend, 806 Main St.

DENVER, COLO.—The Board of Public Works will receive bids until Feb. 24 for grading, curbing and paving Glenarm St., between 14th St. and Broadway.

ELECTRICAL.

HOOSICK FALLS, N. Y.—The five years' contract with the Hoosick Falls Electric Light & Power Co. will soon expire, and the Village Trustees are considering a new contract. The village is now paying $60 per year each for 75 arc lights, moonlight schedule, but it is reported that the service has not been satisfactory.

CHARLOTTE, N. C.—The Charlotte Electric Light Co. will increase the capacity of its plant.

LOUISVILLE, KY.—The Louisville Suburban Land Co. is reported as about to erect an electric light plant.

WINNETKA, ILL.—We are informed by Walter Crew, Village Engr., that Chas. E. Eddy, Portland, Ore., has petitioned for a franchise for two years for electric lighting; streets and residences at 65 cts. per month for 16-c. p. incandescent lights, and $1 per month for 32-c. p. lights for street use.

EAU CLAIRE, WIS.—It is reported that no bids have been received for lighting the streets by electricity and that additional advertising will be done in the spring.

MARSHFIELD, WIS.—The City Clerk will receive bids until March 2 for 23 arc lights of 2,000 c. p. each, the contract to be awarded by the Common Council to the lowest bidder.

KANSAS CITY, MO.—The Board of Public Works has voted to advertise for bids for an electric light plant, to be run by the city hall engines and boilers, or for an entirely separate plant. The Fort Wayne Electric Co., Fort Wayne, Ind., has submitted two propositions, each including 160 arc lights, with 21.7 miles of circuit, at $8 per month per light until the city is ready to purchase the plant. The city now pays $119.50 per year each for 140 lights.

MARSHALL, MO.—We are informed by F. H. Boyd that an ordinance has been passed granting a franchise to Wardell McCully and others, to put in an electric light plant of about 100 arc and 1,000 incandescent lights capacity, the proposition to be submitted to a vote of the citizens Feb. 14.

NEW COMPANIES.—Schuylkill Valley Illuminating Co.; Phoenixville, Pa.; $30,000. Municipal Electric Co., Decatur, Ill.; $25,000; J. H. Culver, J. M. Willard, E. E. Gibson.

CONTRACT PRICES.

LEVEE WORK.—Memphis, Tenn.—Capt. C. McD. Townsend, U. S. Engr., opened bids Jan. 17 for 2,455,000 cu. yds. of levee work. Bids were received from 54 contractors, and ranged from 13 to 27 cts. per cu. yd., the average price being about 18 cts. This work is to be done under the River and Harbor Act of last July, by which $2,665,000 was appropriated annually for three years, commencing July 1, 1893, to carry out the plans of the Mississippi River Commission. Bids for additional work were received Jan. 19 and 24 by Capt. S. W. Roessler, U. S. Engr., and ranged from 14¼ to 22 cts. per cu. yd.

BRICK PAVING.—Moberly, Mo.—We are informed by H. V. Estill, Cy. Engr., that a contract for paving 1,867 sq. yds. with vitrified paving brick has been awarded to the Moberly Brick Tiling & Earthenware Co., at $1.35 per sq. yd., the work to be done in the spring. Last year the city awarded contracts for 7,134 sq. yds. of brick paving at $1.38 per sq. yd., and 15,495 sq. yds. at $1.35. These prices do not include curbing or grading. The specifications call for 4 ins. of sand, then brick laid flat, lengthwise with street, 1 in. of sand on this, then brick laid on edge crosswise to street, 3 ins. laps, and ½ in. sand on top.

PIPE.—Boston, Mass.—The Water Board has awarded the following contract to R. D. Wood & Co., Philadelphia, Pa.; 10 tons of 4-in. pipe, 600 tons of 6-in., 400 tons of 8-in., and 100 tons of 16-in., at $25.94 per gross ton; 390 tons of 24-in. and 1,100 tons of 36-in., at $25.21; and 100 tons of specials, at $25.60; total, $68,910. Other bids ranged from $24.65 to $28.67 for pipe, and $53 to $56.88 for specials.

GRADING.—Winnetka, Ill.—We are informed by Walter Crew, Village Engr., that a contract for grading 2.5 miles of streets has been awarded to John Patterson & Son, Chicago, at 37.5 cts. per lin. ft. The streets are 66 ft. wide, and this price is equivalent to about 25 cts. per cu. yd. for the work to be done.

MISCELLANEOUS.

DRAINAGE CANAL.—Chicago, Ill.—The Drainage Board opened bids Jan. 25 for the excavation of the main drainage canal between Willow Springs and Summit, and the dredging of the Illinois & Michigan Canal between Summit and the South Fork of the Chicago River. The work includes the excavation of about 7,200,000 cu. yds. of earth and 95,000 cu. yds. of rock, the building of 30,000 cu. yds. of retaining walls, and the dredging of 1,800,000 cu. yds. of earth from the Illinois & Michigan Canal.

There were 14 bidders, as follows: John Griffiths, Chicago; Ricker, Lee & Co., Galveston, Tex.; W. S. Carkin, East Saginaw, Mich.; Mason, Hoge & Co., Frankfort, Ky.; Streeter & Kenefick, Kalamazoo, Mich.; Lestner & Qualey, Chicago; Fitz-Simons & Connell Co., Chicago; O. B. Green, Chicago; McArthur Bros., Chicago; L. D. Connor & Co., Harvey, Ill.; Rodgers & Clement, Niagara Falls, N. Y.; Hennessey Bros., St. Paul, Minn.; Western Dredging & Improvement Co., Lafayette, Ind.; Elliott & Phin, Chicago.

The following bids were received for enlarging the Illinois & Michigan Canal—the first price requiring the material dredged to be dumped in the lake, and the second price requiring it deposited on the adjacent banks of the canal: O. B. Green, $777,380 and $668,300; Fitz-Simons & Connell Co., $871,280 and $702,200; W. S. Carkin, $910,140 and $746,520; John Griffiths, $1,208,880 and $1,080,720.

On the excavation of four miles of the canal between Willow Springs and Summit there were ten bidders. Proposition No. 1 is for a channel of 600,000 cu. ft. capacity per minute, and proposition No. 2 for one of 300,000 cu. ft. capacity. There was a wide divergence in the bids, the lowest in each case being as follows: Proposition No. 1.—Hennessey Bros., section A, $809,020; Western Dredging & Improvement Co., section B, $392,245, and section C, $445,066; Streeter & Kenefick, section E, $504,455. Proposition No. 2.—L. D. Connor & Co., section A, $772,525, and section B, $371,601; Western Dredging & Improvement Co., section C, $445,601; Streeter & Kenefick, section E, $504,455. Bids for sections A to F of this work were received Oct. 19, and the lowest prices published in our issue of Oct. 27. The contract for section F was awarded to Ricker, Lee & Co., at $470,040, and that for section D to E. D. Smith & Co., at $479,867, as noted in our issue of Dec. 1.

IRON WORK AND TILES.—Washington, D. C.—Bernard R. Green, Supt. and Engr., has awarded the contract for the iron work for the dome of the Library of Congress to the Tacony Iron & Metal Co., Philadelphia, Pa., at $11,050, and that for hollow terra cotta tiles to the Potomac Terra Cotta Co., Washington, at $1,742.

GRAVEL.—New York, N. Y.—The Department of Public Parks will receive bids until Feb. 8 for screened Roa Hook gravel on Central Park and Riverside Park and Riverside Ave.

MACHINE SHOP.—Hannibal, Mo.—The city proposes to erect a building, put in steam power and pulleys, and then invite mechanics who wish to start in a small way to manufacture any article they may have, to come to Hannibal and occupy this building, power and rent free, or at a nominal cost. This will be an opportunity for a skilled mechanic who wishes to start in business for himself, as he will not have to worry about his rent, the expense of running an engine or repairs.

DRY DOCK.—Ashtabula, O.—The Ashtabula Board of Improvements has been organized to secure a dry dock at this port; Pres., H. M. Kunkle; Secy., J. W. Jacques.

BREAKWATER EXTENSION.—Buffalo, N. Y.—The following total bids (all from local firms) were received Jan. 27 by Maj. E. H. Ruffner, U. S. Engineer Office, for 800 ft. of the shore arm of the breakwater at the harbor: Donnelly Bros., $92,880; W. E. Carroll, $105,007; McNaughton & Babst, $106,255; J. J. Churchyard, $114,972. The lowest bid has been recommended for acceptance.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Richmond Locomotive Works, Richmond, Va., have delivered two freight engines to the Cleveland, Cincinnati, Chicago & St. Louis. The Brooks Locomotive Works, Dunkirk, N. Y., have an order for 6 ten-wheel engines, 4 six-wheel switching engines, and 1 eight-wheel passenger engine for the Chicago & Northern Pacific. The Rhode Island Locomotive Works, Providence, R. I., are building 3 two-cylinder compound express passenger engines for the Chicago, Milwaukee & St. Paul; they have cylinders 19 × 26 ins. and 31 × 26 ins., six 78-in. driving wheels, a four-wheel leading truck and traveling pony truck. The Rio Grande Western is getting satisfactory performance from its four-cylinder compound engines. A small second-hand, standard gage engine is wanted by De Lew & Bailey, Baltimore, Md. The Toledo, St. Louis & Kansas City will add 20 engines to its equipment.

CARS.—The Haskell & Barker Co., Michigan City, Ind., is building 750 furniture cars and 250 flat cars for the Great Northern. The Barney & Smith Car Co., Dayton, O., is building two drawing room cars, $10,000 each, for the Flint & Pere Marquette. The Ohio Falls Car Co., Jeffersonville, Ind., has built 23 fruit cars for the Georgia Central and 2 passenger cars for the East Tennessee, Virginia & Georgia. The American Truck & Car Co., Chicago, Ill.; $240,000; has been organized by Joseph Schneider, E. T. Wray and Leon Elliott.

RAILS.—The Colorado steel & Iron Co., of Pueblo, Col., has an order for 100 miles of steel rails for track renewals on the Union Pacific Ry. The Concord Ry. Co., Concord, N. C., wants 1½ miles of 40-lb. steel T rails, with fastenings.

THE JOHNSON RAILROAD SIGNAL CO., Rahway, N. J., has an order to interlock the New Haven yard of the New York, New Haven & Hartford R. R. This will require an 80 lever Johnson standard interlocking machine. The plan of signals is very complete, and the whole plant will be first-class in every particular. The work is to be carried out at once. The company is also completing nine interlocking plants for the Chesapeake & Ohio R. R.

THE RIEHLE BROS. TESTING MACHINE CO., Philadelphia, Pa., reports several for testing machines of various kinds and for several Riehle-Robie screw jacks.

THE SPRINGFIELD BOILER & MFG. CO., of Springfield, Ill., has opened an office in the Dexter Bldg., Chicago; Man., C. D. Hawkes, formerly with the Porter Boiler Mfg. Co. Mr. Hawkes will devote his time principally to the water-works, stand-pipe and tank department.

COMPRESSED AIR PUMP.—The general western agency for the introduction of the Pohle air lift pump has been given to John F. Haskins & Co., Monadnock Building, Chicago.

THE CARBON STEEL CO., of Pittsburg, Pa., has the contract for furnishing the steel for the new warships "Iowa" and "Brooklyn," from Wm. Cramp & Sons, the principal contractors with the government. This includes the armored protective deck plating. There were eight competitors, including the best known steel and iron companies in the country. The successful bidder has already furnished the steel plates for cruisers Nos. 6 and 13 and the "Oregon." The Carbon Steel Co. succeeded, about five years ago, the old firm of Graff, Bennett & Co., and has since expended about $1,000,000 in extending its plant; the rolls in the plate mill are 124 ins. long by 34 ins. diameter, capable of rolling a plate 10 ft. wide and weighing from 10 to 14 tons. The shears have a 10-ft. stroke, and will cut plates 2½ ins. thick. Electric overhead cranes handle the plates. Horace W. Lash is General Manager and is responsible for the general design and arrangement of this plant. The fact that eight thoroughly responsible firms stood ready to manufacture plates of the dimensions and character demanded by these warships is a telling index of the advance made in this comparatively new American industry within a very few years.

CURRENT PRICES.

RAILS.—New York: $29 at eastern mills, and at tidewater; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $20 for iron and $15.50 to $16 for steel. Chicago: $30 to $32 for standard sections; old rails, $19 for iron and $11.50 to $13.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2 to 2.05 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $12 to $14. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.85 to 3.9 cts.; Chicago: 3.65 to 3.7 cts.; St. Louis: 3.6 cts.

STRUCTURAL MATERIAL.—New York: beams, 1.95 to 2.25 cts. for large lots, and 2.25 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.65 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 1.9 to 1.95 cts.; channels, 1.9 to 1.95 cts.; angles, 1.7 to 1.75 cts.; tees, 2.1 to 2.15 cts.; Z bars, 1.9 cts.; universal mill plates, 1.7 to 1.75 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.7 to 1.75 cts. for tank, 1.95 to 2 cts. for shell, 2.05 to 2.1 cts. for flange, 2.4 to 3.5 cts. for firebox, 1.9 to 2 cts. for bridge. Chicago: beams, 2.17 to 2.25 cts.; channels, 2.27 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; sheared plates, 1.9 to 1.95 cts.; universal plates, 1.9 to 2 cts.; steel plates (at mill), 1.9 to 2 cts. for tank, 2.12 to 2.25 cts. for shell, 2.25 to 2.75 cts. for flange, 2.7 to 2.8 cts. for firebox.